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OPERABLE UNIT 4 PILOT PLANT PHASE II TREATABILITY STUDY WORK PLAN FEMP **DRAFT** MAY 1994

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OPERABLE UNIT 4
PILOT PLANT PHASE II
TREATABILITY STUDY WORK PLAN

Fernald Environmental Management Project
Fernald, Ohio

May 1994

Fernald Field Office
U.S. DEPARTMENT OF ENERGY

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Fernald Environmental Management Project

OPERABLE UNIT 4

PILOT PLANT PHASE II TREATABILITY STUDY WORK PLAN

May 1994

Work Plan Number: WP-18-0006

Fernald Field Office
Department of Energy

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OPERABLE UNIT 4 PILOT PLANT PHASE II
TREATABILITY STUDY WORK PLAN

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LIST OF ACRONYMS

ACA	Amended Consent Agreement
ACOE	United States Army Corps of Engineers
APC	Air Pollution Control
ARARS	Applicable or Relevant and Appropriate Requirements
ASL	Analytical Support Level
ASTM	American Standards for Testing and Materials
AWWTS	Advanced Wastewater Treatment System
BAT	Best Available Technology
BDAT	Best Demonstrated Available Technology
BG	BentoGrout
BMP	Best Management Practices
CAA	Clean Air Act
CAT	Construction Acceptance Testing
CEP	Controls for Environmental Pollution
CERCLA	Comprehensive Environmental Response, Compensation and Liability Act
CFR	Code of Federal Regulations
CRARE	Comprehensive Response Action Risk Evaluation
CRU	CERCLA/RCRA Unit
CWA	Clean Water Act
CWID	Construction Waste Identification/Disposition
CX	Categorical Exclusion
DOD	United States Department of Defense
DOE	United States Department of Energy
DOE-FN	United States Department of Energy - Fernald Field Office
DQO	Data Quality Objective
EDE	Effective Dose Equivalent
EIE	Engineered Isolation Enclosure
EIS	Environmental Impact Statement
EP	Extraction Procedure
EPA	United States Environmental Protection Agency

LIST OF ACRONYMS
(Continued)

ERMC	Environmental Restoration Management Contractor
FEMP	Fernald Environmental Management Project
FERMCO	Fernald Environmental Restoration Management Corporation
FFCA	Federal Facilities Compliance Agreement
FRESH	Fernald Residents for Environmental Safety and Health
FS	Feasibility Study
HASP	General Health and Safety Plan
HEPA	High Efficiency Particulate Air
LLRW	Low Level Radioactive Waste
MAWS	Minimum Additive Waste Stabilization
MEF	Material Evaluation Form
NCP	National Oil and Hazardous Substances Pollution Contingency Plan
NDE	Non-Destructive Evaluation
NDT	Non-Destructive Testing
NEPA	National Environmental Policy Act
NESHAPs	National Emission Standards for Hazardous Air Pollutants
NOI	Notice of Intent
NPDES	National Pollutant Discharge Elimination System
NPL	National Priorities List
NTS	Nevada Test Site
NWP	Nationwide Permit (under CWA)
OAC	Ohio Administrative Code
OEPA	Ohio Environmental Protection Agency
OSHA	Occupational Safety and Health Administration
OTD	Office of Technology Development
OU	Operable Unit
PCT	Product Consistency Test
PNL	Pacific Northwest Laboratory

LIST OF ACRONYMS
(Continued)

PP	Proposed Plan
PPE	Personal Protective Equipment
PSD	Prevention of Significant Deterioration
PSHSP	Project Specific Health and Safety Plan
PTO	Permit to Operate
QA/QC	Quality Assurance/Quality Control
RA	Remedial Action
RCRA	Resource Conservation and Recovery Act
RD	Remedial Design
RD/RA	Remedial Design/Remedial Action
RI	Remedial Investigation
RI/FS	Remedial Investigation/Feasibility Study
ROD	Record of Decision
RSE	Removal Site Evaluation
RTS	Radon Treatment System
SAP	Sampling and Analysis Plan
SCFM	Standard Cubic Feet Per Minute
SCQ	Sitewide CERCLA Quality Assurance Project Plan
SCR	Silicon Control Rectifier
SOT	Systems Operability Testing
SSOP	Site Standard Operating Procedure
SWCR	Sitewide Characterization Report
TBC	To Be Considered
TBD	To Be Determined
TCLP	Toxicity Characteristic Leaching Procedure
TOC	Total Organic Carbon
USEPA	United States Environmental Protection Agency
VOA	Volatile Organic Analyte
WMCO	Westinghouse Materials Company of Ohio

LIST OF WEIGHTS AND MEASURES

°C	degrees Celsius
Ci	Curie
cm	centimeter
d	day
°F	degrees Fahrenheit
ft	feet
ft^2	square feet
ft^3	cubic feet
gpm	gallons per minute
ha	hectares
in	inch
g	gram
kg	kilogram
kg/hr	kilograms per hour
km	kilometer
L	liter
lb	pound
lb/hr	pound per hour
Lpm	liters per minute
m	meter
m^2	square meter
m^3	cubic meter
mi	mile
mtpd	metric ton per day
pCi	picoCurie
ppm	parts per million
psig	pounds per square inch gauge
SCFM	standard cubic feet per minute
wt	weight
yd^3	cubic yard

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LIST OF CHEMICAL SYMBOLS

Ac	Actinium
Ag	Silver
Al	Aluminum
As	Arsenic
B	Boron
Ba	Barium
Bi	Bismuth
C	Carbon
Ca	Calcium
Cd	Cadmium
Cr	Chromium
Fe	Iron
Hg	Mercury
K	Potassium
Li	Lithium
Mg	Magnesium
Mn	Manganese
Na	Sodium
Pa	Protactinium
Pb	Lead
Po	Polonium
Ra	Radium
Rn	Radon
Se	Selenium
Si	Silicon
Tc	Technetium
Th	Thorium
U	Uranium

1.0 PROJECT DESCRIPTION

1.1 OPERABLE UNIT 4 BACKGROUND

The Fernald Environmental Management Project (FEMP) is a contractor-managed federal facility once used for the production of purified uranium metal for the United States Department of Energy (DOE) and United States Department of Defense (DOD). The FEMP is located on 425 hectares (ha) (1050 acres) in a rural area approximately 27 km (17 mi) northwest of Cincinnati, Ohio. On July 18, 1986, a Federal Facilities Compliance Agreement (FFCA) was jointly signed by the United States Environmental Protection Agency (USEPA) and the DOE to ensure that environmental impacts associated with past and present activities at the FEMP are thoroughly investigated so that appropriate remedial actions can be assessed and implemented. This is a requirement under the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA). In 1989, the FEMP was added to the USEPA's National Priorities List (NPL) as one of the sites most urgently requiring remedial response.

The process of investigating the site and developing remedial actions is known as the Remedial Investigation/Feasibility Study (RI/FS). The RI/FS schedule for the FEMP was established in a Consent Agreement (signed in 1990 and amended in 1991) between the DOE and USEPA. To make this process more efficient, the FEMP has been segregated into five sections, depending on physical location and types of waste. These sections are known as operable units (OUs). OU4 is defined as a geographic area that includes Silos 1 and 2 (K-65 Silos), Silo 3 (metal oxide silo), the unused Silo 4, and their ancillary structures. Remediation of OU4 will address all of these items as well as any contaminated soils within the geographic boundary, and any contaminated perched water encountered while conducting OU4 remedial activities.

OU4 is located at the western periphery of the site, south of the waste pit area. The Remedial Investigation (RI) was conducted to determine the nature and extent of contamination in OU4 and to establish remedial action objectives. The Feasibility Study (FS) for OU4 evaluates remedial action alternatives for the silo structures, the materials stored in the silos, and contaminants in the surrounding soils, perched water and all structures within the OU4 boundary. Through the FS process, a wide range of potential remedial actions were developed and screened. Reasonable alternatives underwent detailed and comparative analyses. The "preferred alternative" for OU4 remediation will be proposed and submitted for public review in the Proposed Plan (PP). The Record of Decision (ROD), which is the final step in the RI/FS process, formally approves the alternative(s) that will be used for remediation. For OU4, the approval of the ROD is scheduled to occur in October, 1994.

In addition, it is DOE policy to integrate the National Environmental Policy Act (NEPA) into the procedural and documentation requirements of CERCLA wherever practicable. On May 15, 1990, a Notice of Intent (NOI) was published in the Federal Register indicating that DOE planned to prepare an Environmental Impact Statement (EIS) consistent with NEPA to evaluate the environmental impacts associated with the cleanup actions for each of the five FEMP operable units. Consistent with the NOI, the resulting integrated process and documentation package are termed a Feasibility Study/Proposed Plan-Environmental Impact Statement (FS/PP-EIS).

Currently, the five FEMP operable units are at different stages for evaluating cleanup alternatives; however, each operable unit has identified a leading remedial alternative (see Appendix K of the FS Report for Operable Unit 4). As the cleanup process moves ahead, the leading remedial alternatives may be modified based on new information or on public comments and support agency [EPA and Ohio Environmental Protection Agency (OEPA)] comments. Functioning as the lead CERCLA/NEPA integrated document, the Operable Unit 4 FS/PP-EIS addresses cumulative environmental impacts for implementing the leading remedial alternatives for each FEMP operable unit. The NEPA cumulative analysis focuses on the potential impacts to human health and the environment as the result of implementing one or all of the leading remedial alternatives for the five FEMP operable units. The CERCLA/NEPA integrated documents prepared subsequent to Operable Unit 4 will be derived from, or be fully encompassed by, the impact analysis presented in the Operable Unit 4 FS/PP-EIS. If the leading remedial alternatives for any of the operable units change, additional NEPA review will be performed and documented as appropriate to evaluate the impacts to human health and the environment. This additional analysis will be presented in the integrated CERCLA/NEPA documents for the remaining operable units where appropriate.

1.2 HISTORY AND OPERABLE UNIT DESCRIPTION

Constructed in 1951, Silos 1 and 2 were used for the storage of radium-bearing residues which are by-products of uranium ore processing. Silos 1 and 2 received approximately 6120 m^3 (216,300 ft^3) of residues from 1952 to 1958. Raffinate filter cake (residue from a uranium solvent extraction process) was pumped into the silos as a slurry where the solids settled. The free liquid was decanted through a series of valves and piping vertically spaced symmetrically at various levels along the height of the silo wall. This pumping of slurry, followed by the settling and decanting, continued until the waste material was approximately 1.2 meters (four feet) below the top of the vertical wall. Historic analyses of the K-65 Silo residues indicate elevated levels of Ra-226, Pb-210, Th-230 and natural uranium (U-238) are present in Silos 1 and 2.

Radon and the elements resulting from its decay (referred to as daughter products or progeny) are the nuclides of concern from a health and environmental perspective. Radon is known to be emanating from the silos through cracks and at structural joints. Radon is relatively mobile and capable of migrating through air and water. Through the RI characterization effort, it was found that the berms and subsoils contain localized areas of elevated levels of Pb-210 and Po-210, which are daughter products of radon.

As part of the Silos 1 and 2 Removal Action (Removal Action Number 4 per the Consent Agreement), a layer of Bentogrout (consisting of 30% bentonite clay in water) was placed over the K-65 residues in Silos 1 and 2 to attenuate radon releases to the environment and, in case of a structural failure of the silo dome, reduce the risk of uncontrolled airborne contamination. It is presupposed that the added Bentogrout will be remediated in the same manner as the K-65 material.

Silos 3 and 4 were constructed in 1952 in a manner similar to Silos 1 and 2; however, Silos 3 and 4 were designed to receive dry materials. Raffinate filtrate from refinery operations was dewatered in an evaporator and spray-calcined or kiln-dried to produce a dry waste for placement in Silo 3. The material was blown in under pressure to fill Silo 3.

Silo 3 contains approximately 3900 m^3 (137,500 ft^3) of calcined residues consisting of aluminum, calcium, iron and magnesium oxides, sodium salts; 18,000 kg (39,500 lbs) each of uranium and thorium; and a relatively small amount of radium and other metal oxides. There is no evidence that Silo 3 is a source of contamination to the surrounding areas and underlying soils. Nevertheless, Silo 3 is considered a potential hazard because its contents are radioactive and, in their dry, powdery state, are susceptible to airborne dispersal if exposed to wind.

Silo 4 was never used. Except for rainwater infiltration, which has been observed in the past, it remains empty today.

The Pilot Plant program will provide the design data necessary for the construction of the full-scale vitrification plant for final remediation of Operable Unit 4.

1.3 INTRODUCTION TO THE PILOT PLANT PROGRAM

1.3.1 Purpose and Objective

Operable Unit 4 personnel are currently preparing for the third tier of the USEPA-outlined approach for conducting treatability studies at a Superfund site (refer to Section 1.5). (Although the FEMP is not utilizing Superfund monies, this approach is applicable to the Pilot Plant program.) If the vitrification alternative is selected in the ROD as the final remedy, the third tier [Remedial Design/Remedial Action (RD/RA) Treatability] will consist of the design, construction, and operation of a one metric ton (2,200 lbs) per day output pilot scale facility for vitrification of K-65, bentonite clay, and Silo 3 material. Waste retrieval from the silos and adequate control of radon gas will also be demonstrated. This third tier will be conducted in phases. Phase I of the OU4 Pilot Plant program will utilize bentonite and surrogate materials, the pilot scale vitrification facility, and Silo 4 as a test bed for demonstrating waste retrieval technologies. Phase II, which follows Phase I, will utilize bentonite, actual K-65, and Silo 3 materials which will be retrieved from the silos. This Work Plan covers Phase II of the Pilot Plant program. Phase II will also demonstrate the treatment of radon gas since actual radon emitting materials will be processed. The results of this third tier treatability testing will be used to develop the design of facilities and equipment for the final remediation of Operable Unit 4.

As stated above, the OU4 program for vitrification, waste retrieval, and radon treatment is to be conducted in two phases. It must be noted that while both the vitrification and waste retrieval demonstrations are included in the Phase I pilot program, their operations are considered independent. Phase I will utilize a non-radioactive surrogate material, consisting of silty sands (or washed soil), Bentogrout, and water, that will be placed in Silo 4. Prior to being fed to the vitrification furnace, a metallic stream and sulfates will be added to the surrogate material to more closely simulate K-65 material. No surrogate material will be used to simulate Silo 3 material. Phase I is the equipment, process, and methodology proving stage for the vitrification facility and waste retrieval. The waste retrieval demonstrations will include (1) hydraulic mining and material handling, (2) silo dome modification (enlargement of the center manway), and (3) deployment methods to emulate an environmentally controlled process within the silo. The vitrification facility will be designed for a one metric ton (2,200 lbs) per day of product and will likely operate over a three month period. It is anticipated that Phase I will require approximately 20-30 metric tons (44,000 - 66,000 lbs) of surrogate material to adequately demonstrate vitrification, however, waste retrieval will require as much as 1,500 metric tons (1,650 tons) to be placed in Silo 4 to fully demonstrate the success and effects of a hydraulic mining process. The following is a summary of the activities included in the scope of Phase I:

- Superstructure and Equipment Room Construction
- Silo 4 center manway enlargement
- Silo 4 surrogate material loading
- Hydraulic and mechanical material retrieval demonstrations (Silo 4)
- Pilot scale vitrification facility construction
- Operation of the vitrification facility with surrogate materials

Phase II of pilot scale testing for vitrification will be implemented in the vitrification facility constructed for Phase I. The design for Phase I is being developed for the utilization of actual K-65 and Silo 3 material; therefore, the facility should require minimal modification for Phase II. In addition to the hydraulic removal of actual K-65 material, and the pneumatic removal of material from Silo 3 (both to be used for Phase II vitrification), Phase II will also include radon control for the Silos 1 and 2 headspace gas utilizing the existing radon treatment system with upgraded duct and valving. Radon control at the K-65 silos and off-gas treatment from the vitrification facility will be independent treatment systems. All lessons learned during Phase I, with regard to the process control and equipment operation, will be incorporated into Phase II. As bench-scale testing dictates, Silo 3 material will be mixed in with K-65 material at a predetermined ratio, then vitrified. Similar to Phase I, it is anticipated that adequate testing will require approximately 90 days using 20 metric tons (44,000 lbs) or 10.38 m^3 (367 ft^3) of K-65 material and 10 metric tons (22,000 lbs) or 10.38 m^3 (367 ft^3) of Silo 3 material. Glass formulations currently being developed and optimized will be tested and further optimized (if required) during this phase of pilot scale testing. In addition to several process sampling points, the final glass product will be sampled and tested to ensure that it meets the process acceptance criteria addressed in Sections 3.0 and 6.0. The following are the major activities to be included in the scope of Phase II:

- K-65 Silo Radon Treatment System (RTS) upgrade (valves & ducting) and operation
- Vitrification facility modification (if required)
- K-65 hydraulic material retrieval
- Silo 3 pneumatic material retrieval
- Operation of the vitrification facility using actual K-65 wastes and Silo 3 material
- Treatment of process of off gases

Information obtained from the Phase I & II Pilot Plant program will be used to generate quantitative performance data and to further refine the cost estimate for full-scale remediation. The design will focus on the following remedial alternatives:

- vitrification treatment (Alternatives 2A and 3A.1 for Silos 1 and 2);
- hydraulic waste removal (Alternatives 2A and 3A.1 Silos 1 and 2);
- pneumatic removal and vitrification treatment of Silo 3 material (Alternatives 2B and 3B.1 for Silo 3).

The remedial alternatives considered for OU4 are described in Section 2.

1.3.2 Organization of the Work Plan

This work plan describes Phase II of the OU4 Pilot Plant program for waste retrieval, vitrification and off-gas treatment. It is organized in accordance with EPA guidance (1992) and includes the 15 EPA suggested sections.

In addition, a discussion of the regulatory requirements governing construction and operation of the Pilot Plant, including a permit information summary for Phase II, is included.

This Phase II work plan outlines the implementation actions required for the hydraulic removal of the K-65 material from Silo 1 or 2, the pneumatic removal of the metal oxide material from Silo 3, the vitrification of the actual K-65 and metal oxide material, and the treatment of off gases.

1.4 PREVIOUS VITRIFICATION STUDIES

The OU4 RD/RA Treatability Study for vitrification of the silo materials is being conducted based upon encouraging results from previous laboratory and bench-scale testing. The following sections summarize these results.

1.4.1 Laboratory Testing by Pacific Northwest Laboratory (PNL) in 1991

In February 1991, Westinghouse Materials Company of Ohio (WMCO) published the results of FEMP K-65 residue vitrification tests in the Treatability Study Report, "Characteristics of Fernald's K-65 Residue Before, During, and After Vitrification." The following, which is text from that report, details the background for conducting the vitrification tests, as well as several key findings and test results:

". . . Vitrification of radioactive and hazardous wastes has been under thorough investigation since the mid-1950s. During the high-level waste development program, the U.S. Department of Energy accumulated over 40 years of operating experience with the vitrification process (Chapman and McElroy, 1989). Vitrification has endured international scrutiny and is the preferred international treatment method for the most radioactive and hazardous high-level radioactive wastes (DOE/RL-90-27). Other compelling factors support the use of vitrification for treating many types of hazardous and radioactive wastes:

- *The US EPA has promulgated vitrification as the treatment standard {i.e., best demonstrated available technology (BDAT)} for high-level radioactive mixed waste (Federal Register, June 1, 1991), and a BDAT for arsenic-containing hazardous wastes (Federal Register, ca. May, 1990).*

- *The glass, formed with, at most, minor chemical additions to the waste, generally tests by the Toxicity Characteristic Leachate Procedure (TCLP) or by the Extraction Procedure (EP) toxicity criteria as nonhazardous.*
- *Volume reduction for solids is typically greater than 60 percent."*

"In a vitrified matrix, the diffusion of gases with atomic radii equal to or greater than krypton (1.03 angstrom) and xenon (1.24 angstrom), such as radon (1.34 angstrom), is nil. Thus, once vitrified, release of radon from the residue will be limited to the modest amount of externally exposed surface area. It has been found that volcanic glass has the highest radon retention ability of the 59 rock samples studied. Based upon these favorable processing and product characteristics, vitrification of the K-65 residue is an environmentally progressive and technically sound option for treating this material."

"For the work reported in February 1991, Pacific Northwest Laboratory (PNL) received approximately 15 lbs (7 kg) of the K-65 residue from Silo 1 for vitrification tests. The objectives of the tests were to determine the quantity and composition of off-gas evolved during vitrification, the radon emanation rate from both the original K-65 residue and the vitrified product, and the leachability of the vitrified material.

- *Vitrified K-65 residue (Specific Gravity = 3.1) has a volume that is 35 percent of dried, tamped K-65 residue (Specific Gravity = 1.06), a 65 percent volume reduction.*
- *The radon emanation flux from the K-65 residue was reduced by more than 33,000 times when vitrified. The flux from the original material was measured to be 1.5 million pCi/hr or 52,400 pCi/m^2-S, while glass was 48 pCi/hr or 1.56 pCi/m^2-S (an order of magnitude below the US EPA limit of 20 pCi/m^2-S). We predict that during full-scale processing, the flux may be further reduced by a total factor of up to 90,000 to 2,400,000 because the test crucible had both unmelted material and a coat of glass on the crucible walls. Therefore, the actual surface area exceeded the assumed surface area by a factor of more than 3.*
- *The off-gas data indicate that for the chemicals present, 99.5 percent to 99.95 percent is retained in the glass. This is typical of results obtained during thousands of hours of melter testing with simulated high-level radioactive waste slurries.*
- *As measured by the TCLP, the vitrified K-65 residue tests as nonhazardous. The two TCLP heavy metals present in the glass were barium at 4.4 wt% and lead at 9.9 wt%. The leachate concentrations were 0.98 ppm and 0.3 ppm for barium and lead, respectively, which is well below the limits of 100 and 5 ppm for barium and lead. Results from EP toxicity tests for this (untreated) K-65 residue show a leachate concentration of 0.76 and 630 ppm for barium and lead, respectively. Thus, the vitrified product improved the leach resistance for lead by a factor of over 2000.*
- *The vitrified product is so durable that it could not be dissolved in a hot mixture of concentrated nitric and hydrofluoric acid by Controls for Environmental Pollution (CEP), Inc., during their analyses of the glass."*

The TCLP leachate results from the previous laboratory test for the vitrified K-65 waste are presented in Figure 1-1. The results are well below the established TCLP limits.

1.4.2 Treatability Study for the Vitrification of Residues from Silos 1, 2, and 3

As described in 1.4.1, preliminary vitrification tests for the K-65 material yielded promising results. This supported the development of a more comprehensive vitrification treatability study program for the treatment of all OU4 silo materials. The objective of this subsequent vitrification treatability testing (bench-scale), as described in the vitrification work plan ["OU4 Treatability Study Report for the Vitrification of Residues from Silos 1, 2, and 3" (approved by the US EPA in April, 1992)], was to provide data to allow comparison of vitrification to other remediation treatment technologies based upon the following criteria:

- Leachability of the final product
- Reduction in volume achieved through processing
- Reduction in radon emanation from the waste material

Physical and chemical characterization of the silo material was performed to evaluate vitrification performance. Initial laboratory screening melts were carried out to investigate different glass formulations. Bench-scale melts were then performed. For this, glass formulations were developed for four different mixtures of the K-65, Silo 3, and Bentogrout material. A vitrified product was made and tested in duplicate for each of these mixtures (see Table 1-1). The study results [OU4 Treatability Study Report for the Vitrification of Residues from Silos 1, 2, and 3 (May, 1993)] included the following findings:

- *"The measured radon emanation rate from the glass is approximately equal to the emanation rate from natural building materials such as brick and concrete, even though the radium content of the waste glass is 10^3 to 10^6 times greater than that of natural building materials. A reduction in the radon emanation of about 500,000 times was obtained in the bench-scale vitrification tests."*
- *"Essentially all of the radon initially present in the sample is released during vitrification, providing an upper bound to the expected radon concentration in the off-gas from the vitrification system."*
- *"The final glass product (density from 2.7 to 2.9 g/cm^3) has a volume of about 32 percent to 50 percent of the initial waste volume, representing a volume reduction of 50 percent to 68 percent."*

- *"The PCT results show the durability of the glasses from all four sequences to be comparable to the durability of glasses developed for high-level waste. The normalized leach rates for the elements considered (K, Na, Si, Li, B, U, Th, Ra-226 ranged from 0.0002 to 0.09 g/m²/d. Leaching of radium-226 was one to two orders of magnitude less than the leaching of the major constituents of the glass."*

- *"The vitrified residue from all sequences tested nonhazardous as measured by the TCLP. Previous testing found the untreated K-65 and Silo 3 materials to test hazardous for several metals (lead for K-65; arsenic, cadmium, chromium, and selenium for Silo 3). Lead concentrations in the leachate from the glass were reduced several hundred times relative to the untreated K-65 material, while for the Silo 3 material, arsenic was reduced about 100 times, and cadmium, chromium, and selenium were reduced to less than or near less than detection limits."*

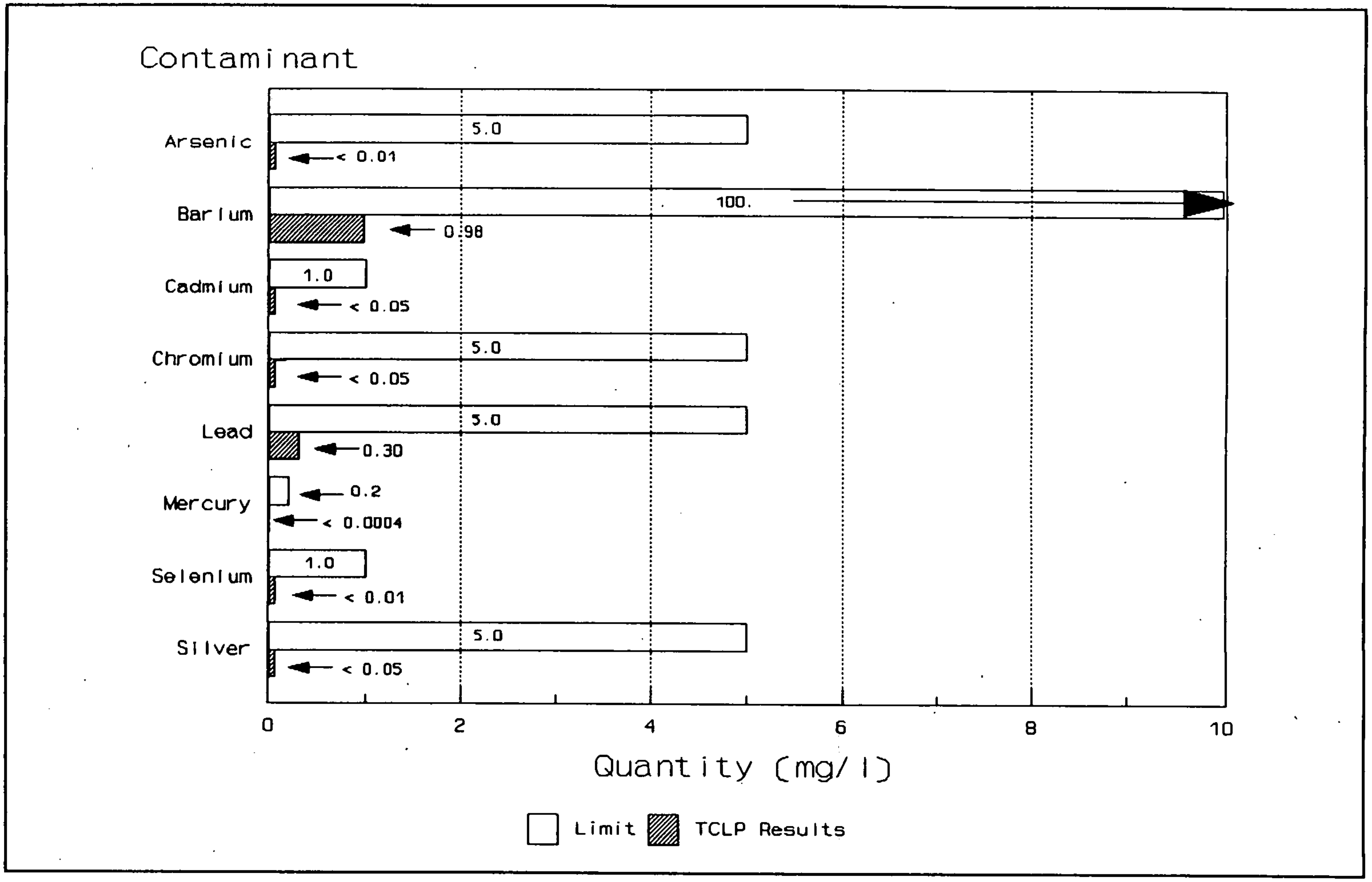


FIGURE 1-1
1991 Laboratory Vitrification Testing TCLP Leachate Results for Vitrified K-65 Material:
Concentration of Metals in Leachate

TABLE 1-1

Summary of Vitrification Tests for OU4 Bench-Scale Treatability Testing

SEQUENCE	TEST*	TYPE OF MATERIAL	APPROX. AMOUNT OF MATERIAL	DESCRIPTION
0		K-65 Silo 3 Bentogrout	As required	Small melts of approx. 100 to 150 grams each to develop glass formulations for the Sequence A through D tests and to test the system and operating procedures.
A	Open	K-65	1.0 kg	K-65 material and glass forming reagents as determined in the Sequence 0 tests. Radon concentration monitored in the off-gas stream.
A	Closed	K-65	1.0 kg	Duplicate of open system test. Off-gas collected for analysis.
B	Open	K-65 Bentogrout	0.5 kg 0.5 kg	K-65 material, Bentogrout, and glass forming reagents as determined in the Sequence 0 tests. Radon concentration monitored in the off-gas stream.
B	Closed	K-65 Bentogrout	0.5 kg 0.5 kg	Duplicate of open system test. Off-gas collected for analysis.
C	Open	Silo 3	1.0 kg	Silo 3 material and glass forming reagents as determined in the Sequence 0 tests.
C	Closed	Silo 3	1.0 kg	Duplicate of open system test. Off-gas collected for analysis.
D	Open	K-65 Silo 3	0.7 kg 0.3 kg	K-65/Silo 3 material and glass forming reagents as determined in the Sequence 0 tests. Radon concentration monitored in the off-gas stream.
D	Closed	K-65 Silo 3	0.7 kg 0.3 kg	Duplicate of open system test. Off-gas collected for analysis.

*Open and closed refers to off-gas system configuration

- *"The fractional release of radionuclides from the glass was similar to that of the major constituents of the glass, indicating that selective leaching of radionuclides did not occur."*

Some of the report's recommendations follow:

- *"Appropriate glass formulations should be developed and acceptable limits of material variability of the waste determined."*

- *"Small-scale tests of systems for removal of radon from the off-gas stream are needed to provide data for designing a radon control system for processing operations."*

- *"Pilot-scale testing in a continuous melter should be carried out to validate the glass formulations developed in crucible melts and to provide data necessary for sizing and design of the full-scale system."*

The first item was pursued as a CRU4 subcontracted glass development project. A radon adsorption experiment utilizing granular activated carbon is currently being implemented at the FEMP site by CRU4 and data should be available this summer. Detailed design (Title II Design) of the OU4 Pilot Plant is currently nearing completion. Any modifications that are required for Phase II operation will be based on lessons learned from the Phase I operation.

1.4.3 <u>Glass Formulation Development</u>

Glass scientists at PNL were authorized to conduct a follow-on study based on the results of the Treatability Study. This follow-on effort focused on optimizing recommended glass formulations for use in the Pilot Plant facility. The development of glass formulations in crucible melts has been completed.

This optimization of glass formulations reduces the risk and will improve the Pilot Plant operational performance. Optimization addresses formulating a glass that has acceptable durability, viscosity, conductivity, and phase stability properties. The program determined the acceptable ranges of additives to respond to the variability in the waste composition at lowest practical furnace temperatures. TCLP results were obtained for the optimized formulation. The operating envelope for the Phase II Pilot Plant tests will focus on processability and robustness of the formulations.

The glass formulations developed in this study used the data from the previous bench-scale melts (performed as a part of the treatability study testing) with particular emphasis being given to the objectionable characteristics that were observed in some of those prior tests. The process concerns were:

- Separation of a molten sulfate layer
- Formation of a reduced metal phase
- Maintenance of the proper viscosity with BentoGrout/K-65 mixtures
- Crystallinity of the Silo 3 glasses

Changes in the formulations to achieve increased glass durability was also investigated.

Beyond accomplishing these specific goals, the general objective for the glass optimization study was to develop glass formulations suitable for use in the pilot-scale vitrification facility. These formulations were to be compatible with the following processing objectives:

- Processability in a joule-heated melter
- Simple, robust formulations
- A durable glass product
- Minimum waste volume

The waste mixtures considered were K-65 alone, a mixture of K-65 and BentoGrout, Silo 3 alone, and a mixture of K-65 and Silo 3. Sequences A to D from the treatability tests are listed in Tables 1-2, 1-3 and 1-4.

To achieve these objectives, a philosophy that consisted of four primary considerations was established as a basis for conducting the study:

- Engineering versus scientific approach

  More than anything, an engineering approach is a recognition of the nature of the problem from a practical, application oriented viewpoint. The scientific approach to the glass formulation problem gives a great deal of attention to small details without recognizing the big picture. An example would be to take a sample of the waste and very carefully develop a glass formulation, optimizing additives to tenths of a percent for that specific sample. This would be fine if the entire waste stream were uniform, but fails to recognize that variability in the waste stream will greatly change the composition from this optimum or can require a complex feed preparation system to maintain this composition. The engineering approach recognizes that variability in the system (especially the waste composition) is large, and that a practical glass formulation must be insensitive to small variations in glass compositions. Scientific detail is obtained as necessary to assure processability and product quality.

- Simple formulations

  Simplicity is a natural result of the engineering approach since the formulation is developed with the application firmly in mind. Simple formulations are those requiring few additives and having little or no variation of the formulation during processing (as a result of variation in the feed composition). Very detailed formulations (i.e., setting strict compositional limits) are difficult to justify given the large degree of variation in the waste feed material.

- Robust formulations

  The formulations should be tolerant of compositional variations in the feed material. A less robust formulation requires more analysis of the waste and adjustment of the formulation to stay within specified limits because the acceptable operational limits are narrower in a less robust formulation. The ideal formulation would have no limits for the given waste stream, i.e., the waste would be blended and processed without requiring any analyses or adjustment to the formulation.

- Minimize waste volume

  A great benefit of vitrification is the ability to effect a large reduction in the treated waste volume. Minimizing waste volume implies maximizing the waste loading. Greater waste loading increases the sensitivity of the glass composition to variability in the feed composition; therefore, a balance is required between increased waste loading and robustness of formulations. The waste loading should be as high as can be achieved while maintaining an adequate degree of robustness.

Glass scientists at PNL optimized glass formulations using data from the previous bench-scale melts performed as part of the treatability study testing (with a reference waste composition material). During screening tests, 100 g (0.22 lb) test melts were made with several different glass formulations. Melts were made with nonradioactive simulants; however, the melt at reference composition for each composition was duplicated using the actual K-65 material. The criteria for deciding on the optimum formulation was based on the TCLP results of the reference glass, the processability, the phase stability and the ability to handle variation in the waste feed composition. The formulations chosen from these screening tests were quantitatively studied during optimization of the formulation. Conclusions from the study are summarized below:

- Partial substitution of CaO for Na_2O prevents the formation of a sulfate layer in the K-65 material in the crucible melts of K-65 material.

  Formation of a sulfate layer in the crucible melts is an indication of potential problems with sulfate in a continuous melter. If the material forms a significant molten salt layer in the crucible melt, continuous processing of metric ton quantities would produce a significant and continually accumulating salt layer. Even if a sulfate layer does not show up in crucible melts, it is likely to be present in continuous processing melter as a result of temperature distribution in the cold cap and the reaction equilibrium. Whether this poses a problem or not depends upon the rate at which sulfate enters the melter versus the rate at which it leaves (through solubility in the glass, and loss in the off-gas via decomposition). Processing at low temperature in the Research Scale Melter (RSM, this type of melter as opposed to all other data coming from crucible melters) has shown that most of the sulfate in the K-65 material can be retained in the glass, although in a somewhat more leachable form. Sulfate was observed on the surface of the melt, but did not appear to be accumulating. Other tests in crucibles mimicking the continuous feeding to a melter at high temperature indicated that the sulfate would not pose a problem at high temperature. The amount of sulfate present at the interface between the cold cap and the molten glass appeared to be the amount that results from equilibrium reactions, not the accumulation of an insoluble sulfate.

- Reduced metals are avoided by eliminating carbon from the formulations. Prior work showed that carbon was effective in preventing the accumulation of an insoluble sulfate layer, but carbon reduced certain compounds to their metallic state. When an alternative to carbon was found, the reduction of metals in the melt was no longer a problem in these tests.

- Proper viscosity can be maintained in glass formulations for K-65/BentoGrout mixtures by basing the amount of additives on the alumina content of the waste feed.

  The alumina content of the BentoGrout is significantly higher than that of the bulk K-65 material; therefore, the melt becomes thicker as the amount of BentoGrout in the waste increases. Since the materials are otherwise similar in composition, the amount of alumina in the waste is indicative of how much BentoGrout is blended with the K-65 material and also a good measure of the quantity of flux required to achieve an acceptable viscosity in the melt.

- A moderate reduction in the waste loading and minor changes in the formulation for the Silo 3 glass results in a vitrified product with a much greater resistance to devitrification/crystallization.

- Robust formulation applicable to the full range of waste compositions ranging from pure K-65 to pure BentoGrout

  As such, this formulation covers and expands upon Sequences A and B from the treatability tests. A practical consideration of the retrieval operation leads to the conclusion that a formulation for the vitrification of the Silo 1 and 2 material would optimally be able to handle the full range of compositions of K-65/BentoGrout mixtures. This formulation ensures the melt has an adequate viscosity for any proportion of K-65 and BentoGrout in the retrieved waste. The effect of variability of the waste composition on the formulation is currently under investigation; however, the variability observed among the different zones in the analysis carried out for the treatability testing does not appear to be great enough to have adverse impact on the glass.

- Simple formulation with common and inexpensive additives.

- Proportion of additives to waste is varied based upon the alumina content of the waste. As discussed above, this maintains a proper processing viscosity. A simple measurement for a single element is all that is required to determine the amount of additives to mix into the waste.

- Simple formulation in that the proportion of additive to waste remains the same.

- Several other formulations of somewhat different compositions also yielded reasonable glasses, demonstrating significant robustness of the formulation.

Increasing the Durability of the Treatability Study Glasses

- Treatability study glasses were very durable.

- Over 30 new and modified formulations for the K-65 material were tested.

This included matching formulations reported in the literature as being acid-resistant, as well as modifying the treatability formulations with additives known for increasing the acid-durability of glasses.

- Only relatively minor improvements in the glass durability can be expected.

  "Relatively minor" is relative to the desired goal of radionuclides in leachate. Maximum improvement in durability as indicated by the leaching of Pb was about a factor of 2. Additional lowering of the leachate concentrations was a result of lower waste loadings (dilution of the waste with additives). As the initial glasses were very durable, the changes in leaching are minor compared to what is required to meet the desired levels. And as simplicity is a key philosophy being followed, the simple formulation of soda and calcia additives would meet this need.

Based on this test data, glass formulations for initial Pilot Plant operation were developed. The recommended formulations are presented in Section 4.4.2, Page 4-14.

1.5 USEPA TREATABILITY GUIDANCE

According to USEPA guidance on conducting Treatability Studies, as many as three tiers of treatability testing may be required (see Figure 1-2):

- Remedy Screening (Laboratory Screening)
- Remedy Selection (Bench-scale or Pilot-scale Testing)
- RD/RA (Pilot-scale or Full-scale)

Operable Unit 4 is currently preparing for the third tier, RD/RA treatability testing for vitrification. RD/RA treatability studies are conducted after the Record of Decision, which states the remedial action selected for the operable unit. The post-ROD study is intended to provide the detailed design, cost and performance data required to optimize the treatment process and the design of a full-scale treatment system. It complements the information obtained during the RI/FS phase; which in the case of Operable Unit 4, is the earlier laboratory and bench-scale treatability studies (see Figure 1-3). As the figure shows, Phase I and II of the pilot-scale testing will occur after the ROD.

The USEPA Guide for Conducting Treatability Studies under CERCLA (1992) lists potential reasons for performing RD/RA treatability testing, including "to support the design of treatment trains." Previous OU4 laboratory and bench-scale treatability study results indicate that vitrification of OU4 materials is a viable treatment alternative. However, the proposed vitrification process must still be proven on a continuous, pilot-scale level prior to performing a full scale facility design. Phases I and II of the Pilot Plant program will accomplish this by providing information on continuous operation performance, maintainability, constructability, equipment sizing, material handling, process upset and recovery, side-stream and residuals generation and treatment (i.e. waste water, radon), energy and reagent usage (i.e process additives), and sampling and analysis of the process and the final product.

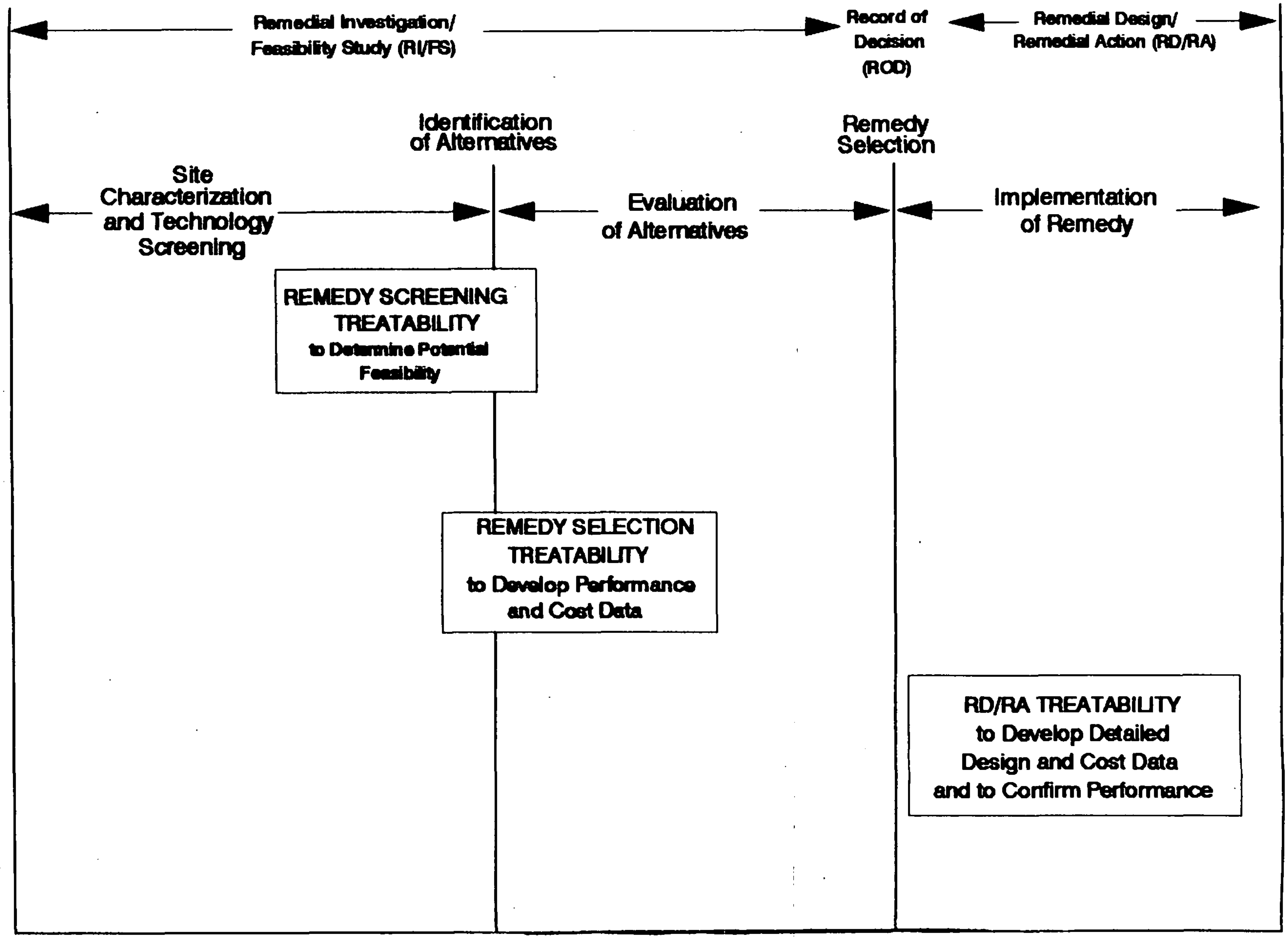


FIGURE 1-2

The Role of Treatability Studies in the RI/FS and RD/RA Process

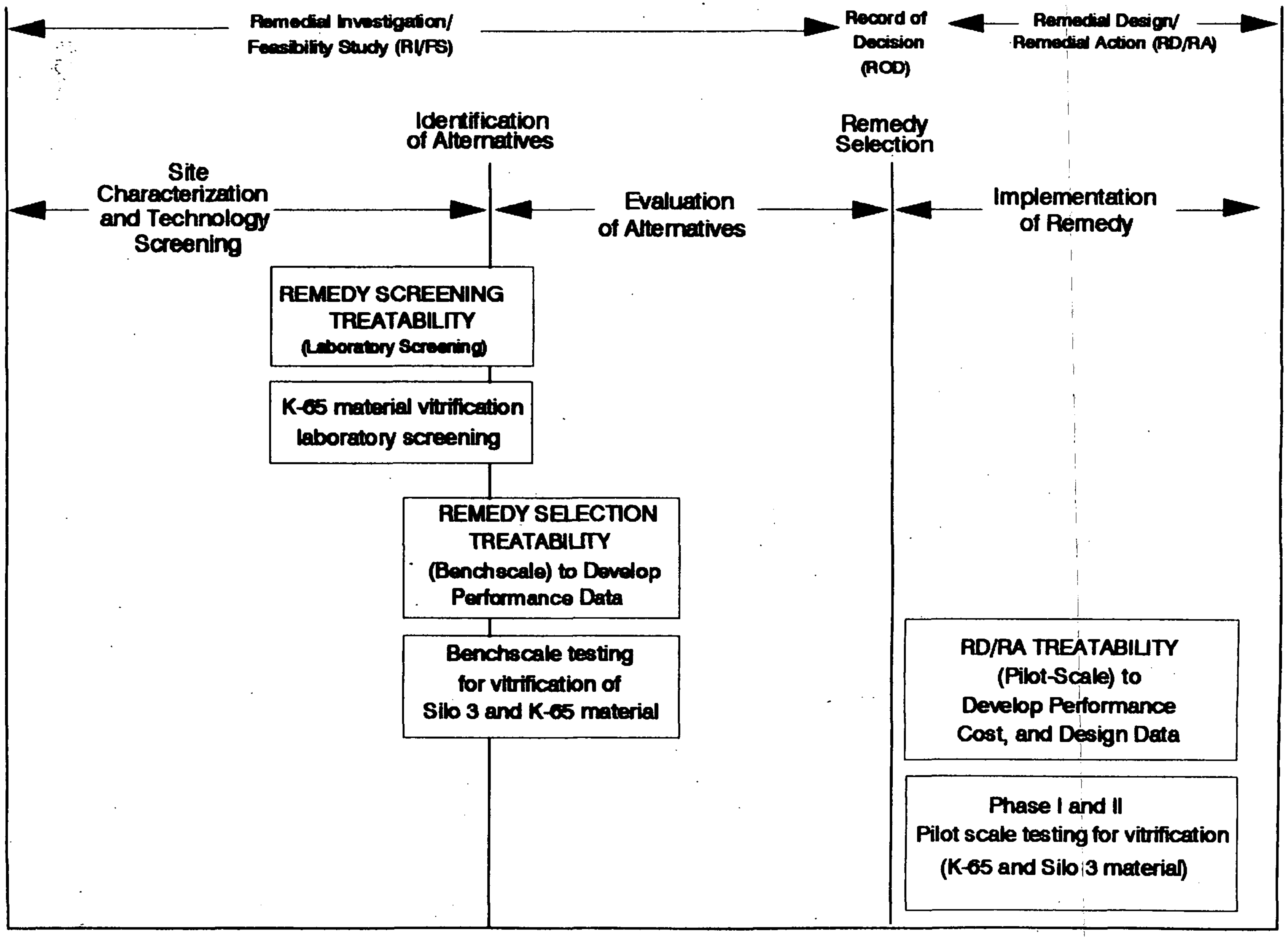


FIGURE 1-3

Relationship of the OU4 Vitrification Treatability Studies to the RI/FS and RD/RA

2.0 REMEDIAL ALTERNATIVE DESCRIPTION

Several remediation approaches are being considered for Operable Unit 4. These alternatives have been described in detail in the DOE report "Initial Screening of Alternatives for Operable Unit 4, Task 12 Report, October 1990." In this report, the contents of Silos 1 and 2 are treated by the same alternatives because the materials in the structures are similar. Silo 3 is treated in separate alternatives. The alternatives have since been revised and included in the Feasibility Study for Operable Unit 4, February 1994.

Phase II of the Pilot Plant program includes demonstrating the processes for:

- hydraulic removal of K-65 residue from Silo 1 or 2.
- pneumatic removal of dry metal oxides from Silo 3.
- vitrification of K-65 material and metal oxides.
- off-gas control and treatment (i.e., radon treatment).

The vitrification technology considered in the following alternatives consists of heating the residues to sufficient temperatures to induce the formation of glass-like mass. The resulting vitreous solid would have a reduced volume. The mobility (leachability) of the constituents of concern in the K-65 and Silo 3 residues would be greatly reduced, and the stabilized waste form would have a greatly reduced radon emanation rate. The vitrified material would be well suited for long-term disposal.

The following remedial alternatives for Silos 1, 2, and 3 contents have been developed and were retained for detailed analysis in the Operable Unit 4 Feasibility Study.

2.1 ALTERNATIVE 2A - REMOVAL, STABILIZATION, AND ON-PROPERTY DISPOSAL

This alternative involves the removal of the Silos 1 and 2 contents, the stabilization of the contents either by vitrification or cement stabilization, and the on-property disposal of the stabilized waste. The technologies implemented by this alternative are hydraulic mining, waste stabilization, on-property disposal, monitoring, and access controls.

Under this alternative, the silo contents would be removed with a hydraulic mining device introduced through the silo domes. This equipment would be supported by a platform spanning the silo. The material would then be pumped to a waste processing facility for cement stabilization or vitrification.

The stabilized waste would then be disposed in an above-grade disposal vault with an inadvertent intrusion barrier constructed on property.

The following is a description of the technologies and process options considered for this alternative:

Hydraulic Removal

The silo contents would be removed with a remotely operated hydraulic mining device suspended from a superstructure constructed over the silos and deployed through the modified dome opening. A primary containment enclosure would be used at the silo dome interface. The hydraulic mining device would consist of a circumferential jetting ring, which would use high pressure water to dislodge and liquefy the wastes, and a slurry pump to pump the slurried wastes from the silos to the waste processing facility. Approximately 90% of the water used would be recycled to the hydraulic removal system. The hydraulic mining device would sluice and transport the bulk of the K-65 material.

Radon Control

A radon treatment system (RTS) would utilize dehumidifiers, carbon adsorbers, and High Efficiency Particulate Air (HEPA) filters to reduce the radon in the silo dome void space during removal operations. The system would maintain the silo headspace under negative pressure to minimize the possibilities of leakage.

Treatment

A waste processing facility would be constructed to house the waste processing, packaging, and waste from sampling/assaying operations. It would incorporate shielding to reduce personnel exposure doses, air treatment systems, and negative pressure ventilation to minimize emissions. All wastes would be staged at this facility prior to disposal.

Waste stabilization - the silo contents would be stabilized by vitrification or cement stabilization. The vitrification process would add glass-making additives, such as soda ash and lime, to produce a glass product with excellent wear and leachability characteristics. The process would utilize additive storage bins, an additive and waste slurry mixer, a glass melter, a fume hood/cap, and an off-gas treatment system. The cement stabilization system would add cement and flyash to produce a monolithic concrete product with very good wear and leachability characteristics. The majority of the water used in removing the wastes from the Silos would be used in the cement stabilization process. The process would require additive storage bins, solids and slurry handling equipment, and an additive/waste slurry mixer.

On-Property Disposal

Above-Grade Disposal Vault - the resultant stabilized waste would be disposed on-property at the FEMP in an on-property, above-grade disposal vault. This facility would be constructed at grade and would utilize a leachate collection/detection system, a multimedia cap, and an inadvertent intrusion barrier.

Monitoring

Radon monitors would be installed around the disposal facility containing the stabilized waste to detect radon that emanates from the facility. Also, a series of groundwater monitoring wells would be installed around the above grade disposal vault and the waste processing facility and be sampled on a routine basis to monitor containment system performance. A leachate collection/detection system would be installed and routinely monitored to assess the performance of the facilities.

Access Controls

A security fence topped with barbed wire would surround the multimedia cap to discourage intruders. A security force would patrol the area during the period of active institutional controls. During this period, access to the site would be confined to authorized personnel only. Permanent physical markers, identifying the disposal area, would also be used. After the institutional control period, deed restrictions and the permanent markers would be used to restrict access.

2.2 ALTERNATIVE 3A.1 - REMOVAL, STABILIZATION AND OFF-SITE DISPOSAL

This alternative involves the removal of the Silos 1 and 2 contents, the stabilization of the contents by either vitrification or cement stabilization, and the off-site disposal of the stabilized wastes. This alternative is identical to Alternative 2A with the exception that the on-property disposal, monitoring, and access controls technologies have been replaced by the waste transportation and off-site disposal technologies. The wastes would be transported to the disposal facility either by rail and/or truck. The following is a description of the additional technologies and process options developed for this alternative:

Waste Transportation

The FEMP can support rail transport to a location near the disposal facility by using existing on-site rail spurs. Currently, there are no direct rail lines to Nevada Test Site (NTS). From a location in the vicinity of NTS, the containers carrying the treated material would be transferred to trucks for over-the-road transportation to NTS. Truck transport can offer portal-to-portal service with the road system available at the FEMP. Improvements to the existing road system in the vicinity of the FEMP may be required to accommodate the increased truck activity.

Off-Site Disposal

The stabilized waste would be shipped to the NTS for disposal. NTS is a DOE-owned facility that currently accepts low-level radioactive waste (LLRW) from DOE facilities. It is located approximately 3219 km (2000 miles) from the FEMP in an arid environment. The Operable Unit 4 remedial waste stream would meet the applicable NTS waste acceptance criteria.

2.3 ALTERNATIVE 2B - REMOVAL, STABILIZATION, AND ON-PROPERTY DISPOSAL

This alternative involves the removal of the Silo 3 contents, the stabilization of the contents by vitrification or cement stabilization, and the on-property disposal of the stabilized waste. The technologies implemented by this alternative are pneumatic removal, waste stabilization, on-property disposal, monitoring, and access controls.

A waste processing facility would be constructed to house the waste processing, packaging, and waste form sampling/assaying operations. It would incorporate shielding, air treatment systems, and negative ventilation to minimize emissions.

The silo contents would be removed with a pneumatic device introduced through the silo domes. This equipment would be supported by a work platform that would span the silo. The material would then be pneumatically conveyed to a waste processing facility for cement stabilization or vitrification. The stabilized waste would then be disposed of in an above-grade disposal vault. The following is a description of the additional technologies and process options developed for this alternative:

Pneumatic Removal

> The silo contents would be removed with a vacuum and cutterhead device. The device would be supported by a work platform spanning the silo and would be introduced into the silos through the four perimeter manways and the off-center opening or through a modified dome opening. The device consists of a cutter-head which would dislodge the wastes and a vacuum nozzle that would pneumatically remove the waste.

Treatment

> Waste stabilization - the silo contents would then be stabilized by vitrification or cement stabilization. The vitrification process would add glass-making additives, such as soda ash and lime, to produce a monolithic glass product with excellent wear and leachability characteristics. The process would utilize additive storage bins, an additive and waste slurry mixer, a glass melter, a fume hood/cap, and an off-gas treatment system. The cement stabilization system would add cement and flyash to produce a monolithic concrete product with very good wear and leachability characteristics. The process would require additive storage bins, solids handling equipment, and an additive/waste slurry mixer.

On-Property Disposal

> Above-Grade Disposal Vault - the resultant stabilized waste would be disposed of on-property in an on-property, above-grade disposal vault. This facility would be constructed at grade and would utilize a leachate collection/detection system, and a multimedia cap, and an inadvertent intrusion barrier.

Monitoring

Radon monitors would be installed around the disposal facility containing the stabilized waste to detect radon that emanates from the facility. Also, a series of groundwater monitoring wells would be installed around the above grade disposal vault and the waste processing facility and sampled on a routine basis to monitor containment system performance. A leachate collection/detection system would be installed and routinely monitored to determine the performance of the facilities.

Access Controls

A security fence topped with barbed wire would surround the multimedia cap to discourage intruders. A security force would patrol the area during the period of institutional controls. During this period of institutional controls, access to the site would be confined to authorized personnel. Permanent physical markers would also be used. After the institutional control period, deed restrictions and the permanent markers would be used to restrict access.

2.4 ALTERNATIVE 3B.1 - REMOVAL, STABILIZATION AND OFF-SITE DISPOSAL

This alternative requires the removal of the Silo 3 contents, the stabilization of the contents by vitrification or cement stabilization, and the off-site disposal of the stabilized wastes. This alternative is identical to Alternative 2B with the exception that the on-property disposal, monitoring, and access controls technologies have been replaced by the waste transportation and off-site disposal technologies. The wastes would be transported to the disposal facility by rail and/or truck. The following is a description of the additional technologies and process options developed for this alternative:

Waste Transportation

The FEMP can support rail transport to a location near the disposal facility by using existing on-site rail spurs. Currently, there are no direct rail lines to NTS. From a location in the vicinity of NTS, the containers carrying the treated material would be transferred to trucks for over-the-road transportation to NTS. Truck transport can offer portal-to-portal service with the road system available at the FEMP. Improvements to the existing road system in the vicinity of the FEMP may be required to accommodate the increased truck activity.

Off-Site Disposal

The stabilized waste and the demolition debris would be shipped to the NTS for disposal. NTS is a DOE-owned facility that currently accepts LLRW from DOE facilities. It is located approximately 3219 km (2000 mi) from the FEMP in an arid environment. The Operable Unit 4 remedial waste stream would meet the applicable NTS waste acceptance criteria.

2.5 ALTERNATIVE 4B - REMOVAL AND ON-PROPERTY DISPOSAL

This alternative requires removal of the Silo 3 contents, packaging, and on-property disposal of the untreated material. This alternative is identical to Alternative 2B, with the exception that it does not include treatment. Under Alternative 4B, approximately 3895 m^3 (5093 yd^3) of contaminated materials would be removed from Silo 3 and packaged in containers for disposal in an on-property above-grade reinforced concrete disposal vault.

3.0 TEST AND DATA QUALITY OBJECTIVES

3.1 PHASE II PROGRAM OBJECTIVES

The overall program objectives for Phase II of the Pilot Plant Project are as follows:

A. Demonstrate the removal of K-65 residue from Silo 1 or 2 via hydraulic slurry mining.

B. Demonstrate pneumatic removal of oxides from Silo 3.

C. Demonstrate continuous conversion of this residue into a vitrified (glass) product.

   1) Determine melter retention time/throughput rates

   2) Determine redox state in melter

   3) Determine waste loading (additive requirements)

   4) Demonstrate salts/sulfate layer treatment

   5) Verify the glass formulation(s) developed in the OU4 Glass program

   6) Evaluate the glass product with respect to waste acceptance criteria

D. Determine slurry settling rates (dewatering) in thickener.

E. Control radon build-up and release using the furnace off-gas and the Silo radon treatment systems.

F. Demonstrate product forming, packaging, and handling.

G. Demonstrate electric power reduction for furnace heating using mechanical agitation.

H. Off-site disposal

This pilot demonstration is intended to provide all the data required to scale up the vitrification process for final remediation of the material in Silos 1, 2, and 3.

3.2 PERFORMANCE OBJECTIVES

This section addresses the specific performance objectives that must be met to demonstrate waste retrieval and the successful production of a stabilized waste form.

3.2.1 Hydraulic Mining

To demonstrate hydraulic mining, the slurry mining machine will be lowered into Silo 1 or 2 through an existing manway. The hydraulic miner will operate intermittently to transfer silo material to the thickener. The hydraulic mining machinery must successfully remove the material from the silo at a rate of approximately 2,270 kg (5,000 lbs) per hour, dry solids basis and a concentration of 15-20 wt percent solids. The device must ultimately supply the pilot scale vitrification facility with about 20 metric tons of K-65 material.

3.2.2 Radon Control

The K-65 RTS must control the release of radon and maintain radon concentrations below required levels during hydraulic device installation and operation. After hydraulic removal, the residue will be resealed with bentonite slurry.

3.2.3 Pneumatic Removal

The pneumatic removal of the dry metal oxides in Silo 3 will be via a simple dilute vacuum system pulling directly from Silo 3 to a filter/receiver located above a hopper mounted on a mobile trailer. The filtered off-gas discharges into the Silo 3 headspace. The transfer rate will be approximately 2,730 kg/hr (6,000 lb/hr) with the target quantity being approximately 10 metric tons. The filled hopper will be moved from Silo 3 to the vitrification building for unloading.

3.2.4 Solids Dewatering

Solids dewatering consists of the gravity thickener which is designed to increase solids content of the transferred slurry to 50 wt percent. This equipment will be tested on the material mined from Silo 1 or 2. The solids content target must be met within about 8 hours of transferring solids to the thickener. The settling of bentonite clay is difficult, therefore, slurry mixed with bentonite will likely require special attention and additional time to meet the target.

3.2.5 Vitrification

The primary objective is to demonstrate vitrification furnace operation at a continuous throughput of 1000 kg (2200 lb) of glass product per 24 hour day. A secondary objective is to verify that the formulations developed from the OU4 bench-scale studies and glass development program will produce a satisfactory glass product. The glass product will be judged to be adequate by its resistance to leaching, its physical properties, and compliance with the acceptance criteria of the disposal location (Nevada Test

Site) identified in the Proposed Plan for Remedial Actions at Operable Unit 4. Another secondary objective is to demonstrate the relative effect of agitation on the expected salts/sulfate layer and the required furnace temperature. It is predicted that agitation will minimize phase separation and thus reduce the required furnace temperature.

3.2.6 Final Product Handling

The molten product must be cooled, formed, and packaged for storage. Product in the form of gems that are placed in a drum is the primary approach, but the capability to bypass the product-forming machine to produce glass slabs or monoliths is included in the design. The product forming machine and drum filling equipment must accommodate the furnace throughput.

3.2.7 Furnace Off-gas Treatment

The furnace off-gas treatment system includes the quench tower, scrubber, desiccant tower, carbon beds, and final HEPA filter. This system must meet design specifications and result in an atmospheric discharge within regulatory limits. Monitoring will be conducted on the off-gas stream prior to entry into the quench tower, and then within the stack to verify acceptable performance of the control equipment on particulates and gaseous effluents. Further discussion of Regulatory Compliance for the off-gas system is found in Chapters 10 and 16. Regulatory limits are listed in Appendix C.

In addition to off-gas monitoring, existing radon detection instruments at the FEMP fenceline and new monitors at the Pilot Plant will be closely watched to meet the objective of adequate radon control.

3.2.8 Off-site Disposal

A primary objective is to meet acceptance criteria for disposal at NTS (NVO-325 Rev. 1) and relevant Department of Transportation requirements.

3.3 DATA QUALITY OBJECTIVES (DQOs)

Previous studies of K-65 and Silo 3 materials using vitrification on bench and laboratory scales have shown positive results which will support remediation of OU4. Several formulations developed have shown promise and it is now necessary to move the study of K-65 and Silo 3 material vitrification from laboratory and bench scale models and formulations to a pilot scale facility. The pilot scale facility will test and develop formulations for vitrification which will support the OU4 Proposed Plan Alternatives 2A, 3A.1, 2B, and 3B.1. The pilot plant testing will develop the final remediation vitrification processes, if this alternative is selected by the USEPA.

The Phase II Work Plan sampling identified in Section 6.0, Tables 6-1 and 6-2 will provide data to determine the optimum operating parameters for the Pilot Plant and will verify the facility performance using the K-65 Silo materials and Silo 3 metal oxides. The Analytical Support Levels (ASL) and quality assurance sampling requirements are identified in the table. Based on Tables 6-1 and 6-2, the SCQ requirements for completeness, representativeness, and comparability will be achieved for the treatability studies.

Other data objectives included in this Work Plan include process controls activities necessary to support the testing required for this Work Plan. These are provided in Tables 6-1 and 6-2 with objectives and sampling to determine if processes are in control. These are included as directed by the SCQ Section 1.

Proposed Alternatives 2A, 3A.1, 2B, and 3B.1 require the K-65 and Silo 3 material be stabilized. This Work Plan supports the study of vitrification for stabilization. If the final Record of Decision from USEPA directs the K-65 and Silo 3 material be stabilized in a vitrified form, then the results of the work Plan study will support final remediation.

Based on previous studies, several formulations used in the bench and laboratory tests produced the glass required. The pilot plant will study these formulations for scale up and process controls. The formulations should produce the desired results, however it is necessary to study the larger scale process which may vary the previous test results. It is necessary to develop and determine the optimum process using the variables for durability, reduction, chemical and physical mixes, results from TCLP and PCT tests for leachability and other process requirements. If several formulations are equal and successful, then other variables such as schedule and cost may be considered in the determination of the final process.

In Section 6.0, Tables 6-1 and 6-2 are provided as a matrix to balance the chemical and process engineering necessary to complete this study.

The treatability study does not include treatment of soil removed from around the Silo 4 area. FERMCO's Waste Management Department issued a letter [M:RSO:(WM):94-0050, CRU4 Pilot Plant Construction Project, dated January 14, 1994] stating that characterization is complete.

4.0 EXPERIMENTAL DESIGN AND PROCEDURES

Phase II begins with a Pilot Plant that has been thoroughly tested on surrogate material during Phase I operations. All instruments will have been calibrated and all vessels will have proper inventories of liquid, solid, or slurry material. The furnace will be hot with an inventory of molten surrogate glass.

4.1 DESIGN ACTIVITIES/DESIGN BASIS

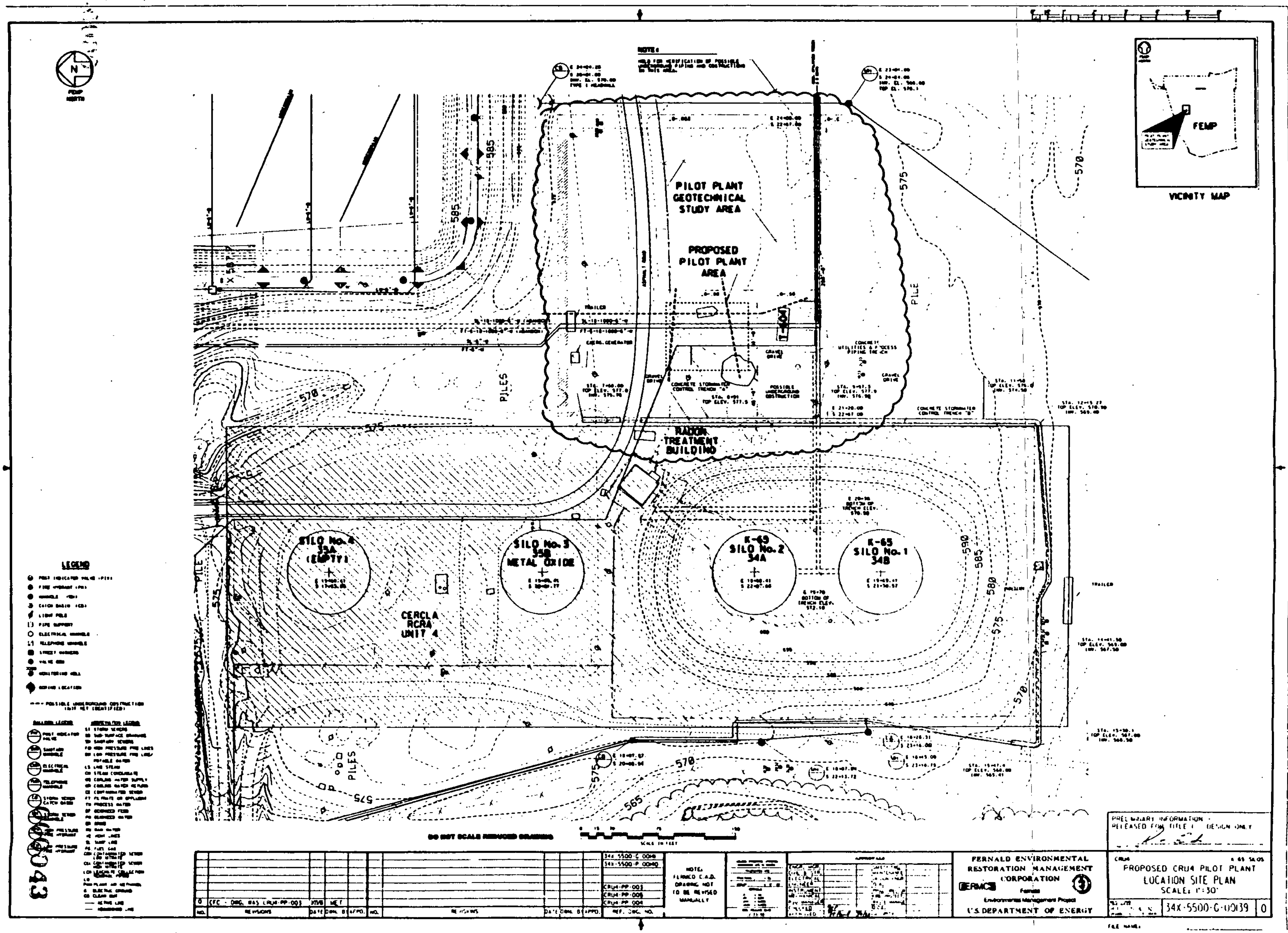
The hydraulic mining device, to be deployed through an existing manway in Silo 1 or 2, will consist of a slurry pump and a sink ring with spray nozzles combined into one compact and portable assembly. This assembly will be specified to sluice material from a local area directly under the manway. Its primary purpose will be to supply K-65 material as feed material for the vitrification facility. This pump's mining performance will produce only a small opening in the bentonite cap to reduce the amount of additional bentonite needed to repair the breach.

The pneumatic removal of material from Silo 3 will be via a vacuum gulping system, which will draw the material out through a pipe inserted through an existing manway. A mechanical arm controlled by an operator will manipulate the gulper pipe.

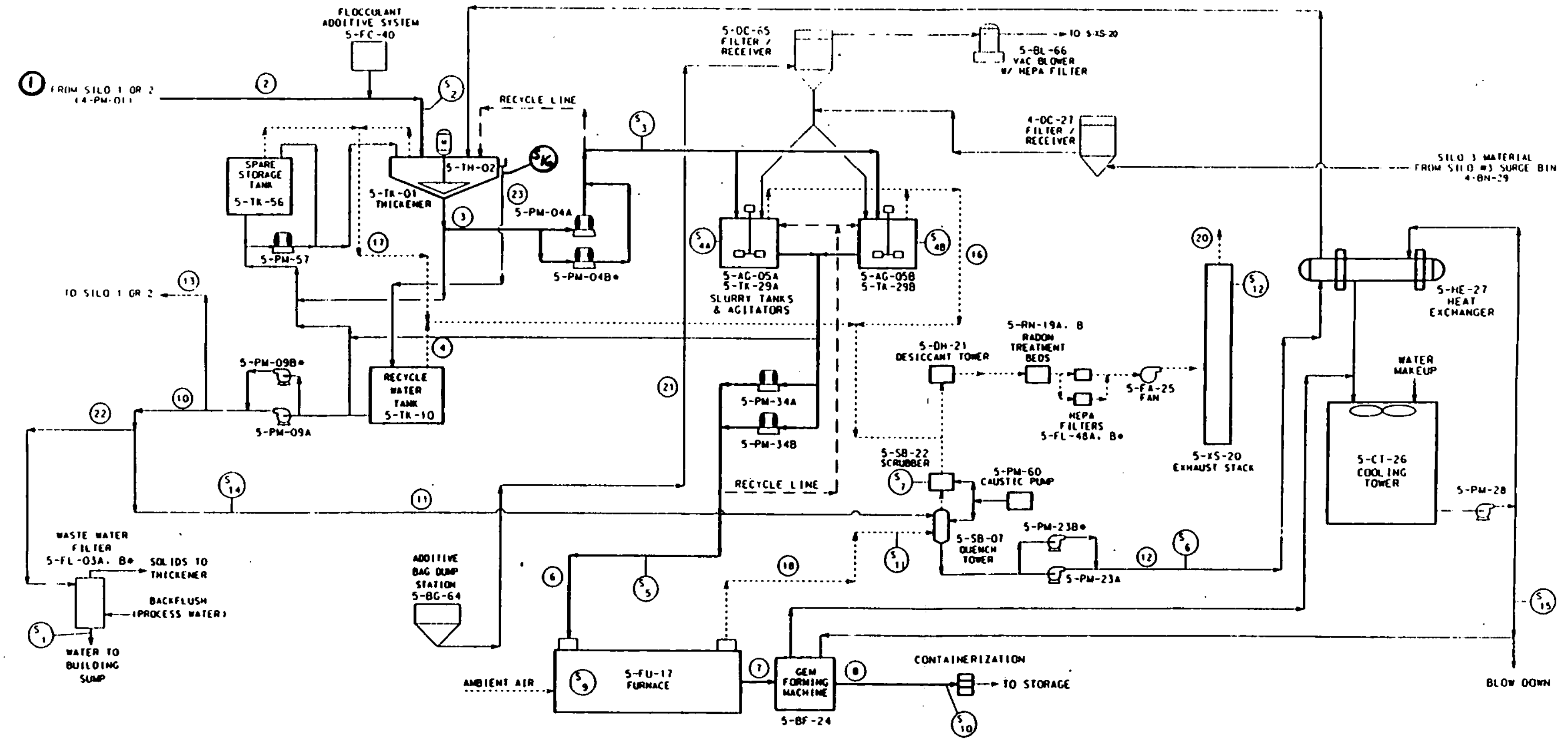
The pilot-scale vitrification facility will be located east of the K-65 Silos (see Figure 4-1) and will include interim storage of the vitrified product. The majority of the holding tanks and vitrification support equipment will be located outside the building on diked concrete pads. However, the melter and product forming equipment along with the process control system and other support functions will be housed in a pre-engineered metal building. The preliminary list of equipment and materials required are listed in Section 5.0. A preliminary process flow diagram (see Figure 4-2) and a block flowchart (see Figure 4-3) for the vitrification facility were also developed.

FIGURE 4-1

CRU4 Pilot Plant Site



OU-4 PILOT PLANT PROCESS FLOW DIAGRAM - PHASE II



NOTE: * - INSTALLED SPARE

(S) - SAMPLING POINTS

FLOW NO.	1	2	3	4	6	7	8	10	10	11	12	13	16	17	18	20	21	22	23	23
	K-65 SILO MATERIAL	SLURRIED MATERIAL	SLURRY TANK FEED	OFFGAS FROM WATER TANK	FURNACE FEED	FURNACE PRODUCT	FINAL GLASS PRODUCT	RECYCLE WATER		H2O FOR OFFGAS QUENCH TOWER	WATER FROM QUENCH TOWER	H2O FOR HYDRAULIC REMOVAL	OFFGAS FROM SLURRY TANKS	OFFGAS FROM THICKENER	OFFGAS FROM FURNACE	OFFGAS TO ATM	FURNACE FEED ADDITIVES	H2O TO BE TREATED	THICKENER OVERFLOW	
AIR (SCFM)				50									100	50	50	250				
SOLIDS (LBS/HR)	4450	4450	4450	0	92	92	92	0	0	0	0	0	0	0	0	0	1080	0	0	0
WATER (LBS/HR)	1910	17800	4450	0	74	0	0	21910	20000	20000	20074	15890	0	0	74	0	0	1910	33424	20074
OPER. TIME (HR/DAY)	0.4	0.4	0.4	24	24	24	24	0.4	23.6	24	24	0.4	24	24	24	24	0.4	0.4	0.4	23.6

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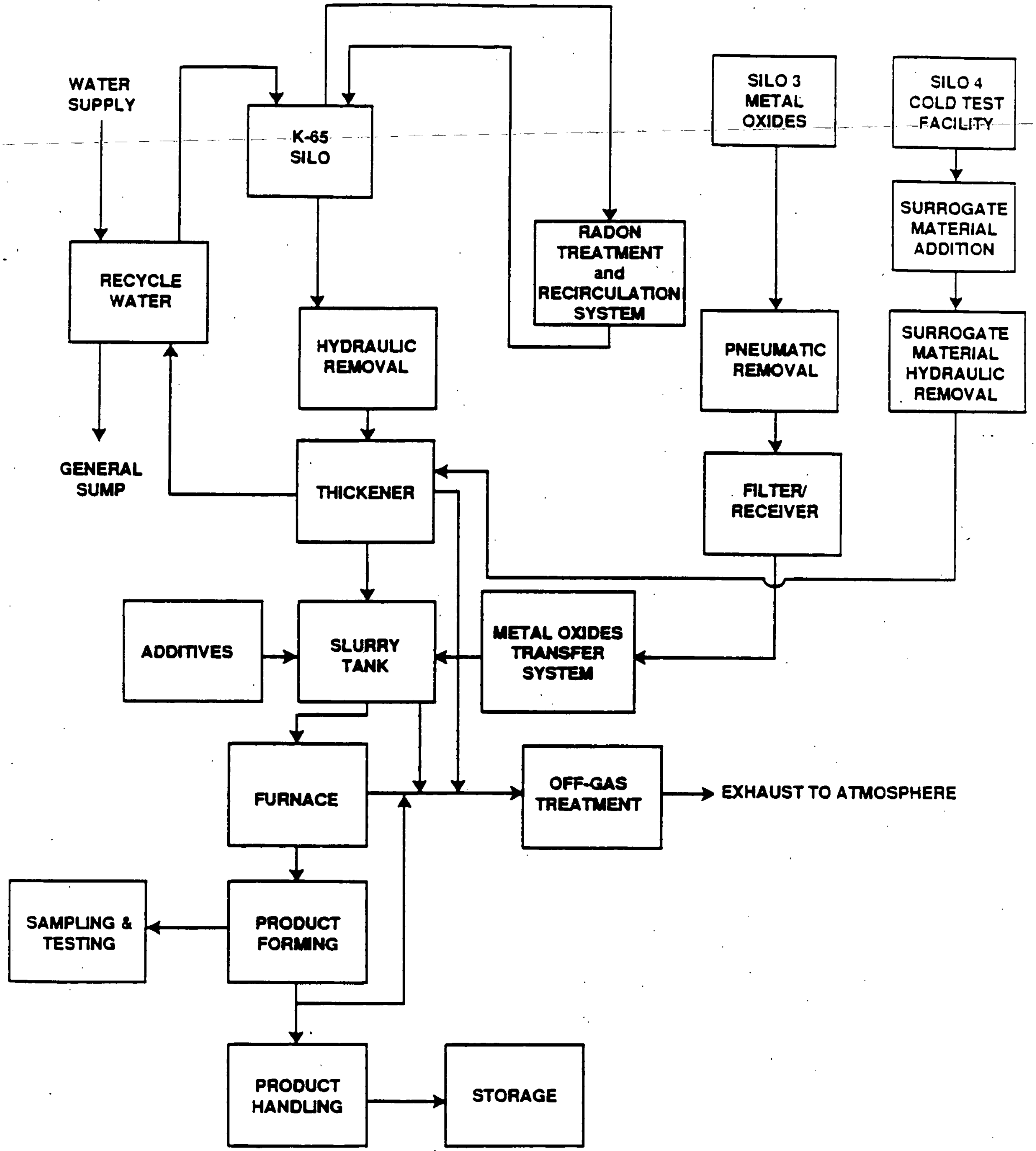
FIGURE 4-2

CRU4 Pilot Plant Process Flow Diagram - Phase II

FIGURE 4-3

Pilot Plant Program Block Flowchart



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4.1.1 Design for Silo Activities

Hydraulic Mining and Deployment Equipment

The hydraulic mining device will be deployed through an existing (unmodified) manway and supported by a mobile crane. The pressurized spray nozzle discharge shall dislodge approximately 2270 kg/hr (5000 lb/hr) dry weight solids to the pump inlet. The slurry pump shall be capable of operating in submersible conditions, provide an 18 m (60 ft) minimum pressure head, and remove slurry at up to 190 Lpm (50 gpm) at 15 to 20 wt percent solids. The cutting action of the pump will be directed downward rather than radially to form a cylindrical cut into the bentonite cap and K-65 residue using a sink ring to cut a hole the approximate diameter of the pump. The sink ring water jets will be supplied recycled water at about 200 pounds per square inch gauge (psig). Pieces of consolidated material which cannot be broken up by the water jets and pump agitator will remain in the silo.

Radon Control at Silos

Radon control will be attained during a bag-in/bag-out glove-bag procedure while inserting the slurry pump into Silo 1 or 2 without allowing a direct route for radon to escape to the atmosphere. The existing recirculating 1000 Standard Cubic Feet per Minute (SCFM) RTS will be upgraded by replacing the valves and PVC pipe with stainless steel ducting. The upgraded RTS will be run as needed to provide a reduction of the radon concentration in the Silo headspace.

Silo 3 material produces much less radon than does the K-65 material. Silo 3 radon can be adequately controlled by using bag-in/bag-out techniques to keep the Silo 3 headspace atmosphere isolated from the ambient atmosphere during material removal activities.

The job-specific Health and Safety Plan will require monitoring when personnel are working in the silo area.

Pneumatic Removal Equipment

The pneumatic removal system for Silo 3 will pull about 2730 kg/hr (6000 lb/hr) of dry metal oxides from Silo 3 to a mobile hopper. The removal system is designed as a closed-loop system. Filtered exhaust will be discharged back into the Silo 3 headspace. The filled hopper will be moved via truck or crane to the vitrification facility. Sufficient material will be inventoried to last the estimated duration of the Phase II vitrification runs.

4.1.2 Design for Pilot Plant Facility

The pilot-scale electric melter is the prime component of the Pilot Plant facility. The vitrification furnace will be an electric-heated melter capable of melting a wide range of waste materials, with minimal additives, at moderately high temperatures. It will utilize joule heating, which means that the electric current passes directly through the molten glass, and will be designed to produce a consistent, durable, stabilized glass with minimal effluent. The melter will be lined with high temperature refractory bricks and will generally operate in the range of 1,050 to 1,400°C (1,922 - 2,552 °F). Melter and melt chamber temperatures will be controlled by power adjustments to the heating electrodes and supplemental area heaters. The melter will have agitation incorporated into its design to allow uniform glass production at the lowest possible temperature and molten glass retention time.

The molten glass will be fed to a product forming machine that will produce a glass product of shape and size that will facilitate containerization and anticipated final packaging. The gem forming machine used on the experimental MAWS (Minimum Additive Waste Stabilization) melter might meet these requirements and is currently the preferred method. A back-up waste form is the cast monolith which will also be tested as part of Phase II activities.

Included will be an off-gas system composed of standard industry components such as a quench tower to reduce melter off-gas temperature, scrubber, desiccant tower, carbon adsorption beds, HEPA filter, and blower. The off-gas air will be discharged to the atmosphere through a stack. The stack will be equipped with an isokinetic sampler which will monitor the off-gas system to verify that particulate and gaseous radionuclide emissions are within regulatory limits during vitrification of K-65 and Silo 3 residues.

Additives

Chemical additives, such as Na_2CO_3 (sodium carbonate) and $CaCO_3$ (calcium carbonate), needed for the vitrification process will be weighed and then fed to the slurry tanks and blended with the K-65 and Silo 3 materials. The additive addition equipment will be a standard bag slitting and dumping station.

Feed Make-Up

The glass formulation (i.e., the required amount of additives) for Phase II will be based on the results of the current bench-scale OU4 glass development program. The material will be melted and the resultant glass analyzed and tested. If the glass is determined to have characteristics that indicate poor durability, i.e., phase separation, excessive leachability, or improper viscosity at the desired temperature, an adjustment to the formulation (and/or furnace temperature) will be made.

Thickener

The slurried K-65 material will be pumped from Silo 1 or 2 to the thickener tank through double containment piping. The feed will enter the centerwell of the thickener. Slurry flow rates and percent solids will be measured by a flow indicator installed in the feed line.

Control of thickened solids in the underflow will be by an adjustable, air-operated diaphragm pump that will pump the material to one of two slurry tanks. A density controller in the thickener underflow line will control the density of the solids by adjusting the diaphragm pump flow rate. The underflow is designed for 50 percent solids and will be confirmed as part of the Pilot Plant operations. The thickener overflow will flow by gravity to the recycle water tank where it will be used to supply the quench tower and the hydraulic miner (as required). A flow indicator similar to the one in the thickener feed line will be installed in the thickener discharge (underflow) line.

A flocculant will be necessary to ensure an adequate settling rate of the solids in the thickener and will be added using a flocculant mixing and feeding system. A settling test utilizing bentonite is planned under a separate sub-project.

The thickener mechanism will be supplied with protective instrumentation to lift and lower the rakes automatically, depending on torque. Torque alarm annunciation will occur on the activation of a high torque sensor and automatic shutdown will occur on the activation of a high-high torque sensor.

Slurry Tanks

The two agitated slurry tanks will alternate between feed preparation and melter feed functions. While one tank feeds the melter, the other tank will receive about 810 kg (1780 lb) of solids as thickener underflow. This represents about one day's production, so the complete cycle of slurry tank fill, additive addition, mixing, and verification shall take place in 24 hours (or less).

Dry metal oxide material will be pneumatically conveyed from the relocated surge bin (transferred from Silo 3) and mixed with K-65 material in the slurry tanks, as testing dictates. After all the Silo 3 material in a slurry tank has been mixed, a sample will be taken and analyzed to determine the additives needed. The amount of additives added will be based primarily on the silica to alumina ratio. The solids content desired in the final slurry is about 60 wt percent. Crucible testing will be performed on the chosen composition to determine if a suitable glass is produced.

Melter

The slurry will be delivered from the slurry tank to the melter by an air operated diaphragm pump. The feed will enter the melting chamber and be deposited onto the molten glass surface. Since the feed to the melter would be very low on a continuous basis, the slurry will be fed at a higher, intermittent rate. The materials will be melted by a series of electrodes and will be agitated. The molten glass will be retained for the necessary retention time in order to attain homogeneous vitrification.

The operating parameters are as follows:

Discharge Rate	1.0 metric ton(2200 lb)/day
Operating Temperature	1050 - 1400°C (1922-2552°F)
Feed Moisture	40 - 50 percent by weight
Feed Temperature	10 - 40°C (50 - 104°F)
Bath Surface Area	9 ft^2 (0.84 m^2)
Bath Volume	27 ft^3 (0.76 m^3)

Melter Glass Discharge

While feeding is in progress, molten glass inventory will be accumulated in the melting cavity and discharged through the forehearth into the gem forming machine or directly into a casting container. The gem forming machine consists of a mechanism to break the molten glass stream into droplets which fall onto a rotating platten. The gems are air-cooled on the platten and mechanically ploughed off into a drum. (The design of the gem-forming machine is based on an existing gem maker that is currently being used in the MAWS program. The design or the actual mechanics of the Pilot Plant gem maker is subject to change when the procurement is awarded and design approved.)

Melter Pressure

The melter will normally be kept at a slightly negative pressure. This will be accomplished by venting the melter into an induced-draft, once-through off-gas system.

Off-Gas System

The off-gas system will consist of a quench tower, scrubber, desiccant tower, radon adsorption carbon beds, HEPA filter, blower, and stack. The quench tower receives hot gases from the melter and quenches it using 40 gpm recycle water. Tower internals will consist of spray nozzles and/or baffles. The scrubber will use a recirculating caustic solution to remove sulfur oxides (SO_X) and any other acidic gases from the gas stream. The desiccant tower consists of a desiccant bed to reduce the relative humidity to under 15 percent. Two parallel carbon bed trains will be used, each designed to reduce the radon content of the 250 SCFM off-gas stream by 97 percent. If more radon removal is needed, the two trains can be run simultaneously. The HEPA filter is a cartridge unit which will be the final off-gas treatment process before discharge through the exhaust fan and out the stack. The off-gas system will vent the thickener, slurry tanks, recycle water tank, and melter. Air throughput will be minimized (nominally 250 SCFM) to maximize the effectiveness of the carbon beds. Radon control during Phase II will be based on regulatory limits as listed in the Applicable or Relevant and Appropriate Requirements (ARARs) in Appendix C.

Waste Water Treatment System

The waste water treatment system will be sized to handle approximately 38 Lpm (10 gpm) of waste water (containing suspended solids and salts) on an intermittent basis as required. Treatment will consist of a multimedia, deep bed, pressure filtration system. Backwash from the filter will go to the thickener. Two filters will be used so one is available when one is being backwashed.

Cooling Tower

Cooling tower water will circulate through the heat exchanger used to cool the quench tower effluent being recycled to the thickener, and possibly other minor users such as cooling the product-forming machine.

4.2 CONSTRUCTION ACTIVITIES

The only significant construction activity planned for Phase II is the installation of the water, slurry, and power lines to the K-65 Silos and the K-65 RTS upgrade. Also, Pilot Plant operations during Phase I will reveal any deficiencies in the equipment or process. Construction will be responsible for replacing inadequate or defective equipment or making construction modifications to the process as necessary.

4.3 CHECKOUT AND START-UP ACTIVITIES

Following the successful completion of Phase I, operating procedures will be modified to reflect all process changes and lessons learned.

4.3.1 Checkout Activities

The following is a preliminary list of checkout activities.

A. All liquid process lines will be flushed to remove residual materials used during Phase I testing.

B. Waste retrieval equipment (cranes, pumps, vacuum blowers, cameras, etc.) and the system as a whole will be tested for proper operation.

C. The thickener will be emptied of surrogate material and left filled with water to the point of overflow into the recycle water tank.

D. The recycle water tank will be checked to make sure it is at a 60 percent to 70 percent level indication.

E. The quench tower will be checked for proper (about 50 percent) water level.

F. The exhaust fan will be started, and air flows from the process through the off-gas system will be remeasured and balanced.

G. The cooling tower will be checked for proper water inventory and treatment chemicals will be added as needed. The cooling tower pump will be run to purge air from the system. The cooling tower fan will be started and adequate air flow verified.

H. The transfer equipment for the glass additives will be checked to confirm proper operation.

I. Slurry tanks will be emptied and flushed.

J. The furnace will be checked for proper temperature control.

K. Both of the waste water filters will be back-flushed and ready for use.

L. During the checkout operations, the Distributed Control System will be monitored for correct indications of measured variables, control action, and status of motors and valves.

M. Safety alarms will be checked and emergency shut-offs will be tested for proper settings and functionality.

N. Isokinetic stack sampler will be tested in accordance with EPA methods.

4.3.2 Start-up Activities

Start-up activities at the Silos involve filling the surge bin with Silo 3 material and inserting the slurry pump into Silo 1 or 2. Start-up activities for vitrification involve introducing K-65, Silo 3, and additive materials into the system and inventorying tanks and bins so that continuous operation can be achieved. These activities consist of the following essential steps:

A. The Silo 3 material surge bin will be filled and relocated to the Pilot Plant facility.

B. The K-65 Silo radon treatment system will be started and checked for satisfactory operation.

C. The slurry pump will be inserted into Silo 1 or 2 and slurry transfer to the thickener will commence.

D. When adequate percent solids is reached in the thickener, the first "hot" melter feed batch will be initiated by transferring the correct amount of thickened solids to one of the slurry mix tanks.

E. Additives will then be added to the slurry tank. After the additives are sufficiently mixed in the slurry tank, short furnace feeding runs will be used to test the furnace feed system on this material and get an initial assessment of the response of the furnace to the feed.

F. Molten glass draw and the gem forming equipment will be tested in short runs to properly establish control parameters during the switchover from surrogate material to "hot" glass.

G. The recycle water system, off-gas treatment system, waste water filters (as required), and cooling tower will all be operating during this time.

H. These start-up activities will cease when all systems have been tested sufficiently such that continuous operation is judged to be viable.

I. Control software quality checks.

4.4 PILOT PLANT TESTING

The objective of this operational phase is to achieve design rates on a continuous operation basis and to determine steady-state and optimum parameters while producing a good glass. The majority of this phase of Pilot Plant testing will include equipment operation, sampling, observation, and subsequent process correction. Phase II vitrification testing is targeted to end when sufficient samples and data have been collected to demonstrate attainment of the goals to support remedial design. It is estimated that this will require approximately 20-30 metric tons of K-65 and Silo 3 material to be vitrified. The following identify the specific component testing that will occur.

4.4.1 Equipment Operation

K-65 Silo Material Retrieval (Hydraulic)

Testing of K-65 Silo material retrieval will include successful manipulation of the slurry pump, demonstration of the ability to control radon emissions, and removal of Silo material at the design rate. Slurry samples will be taken periodically to monitor the performance of the hydraulic mining system. The slurry pump operating pressure and flow will be adjusted to test its operating range and to determine optimum operating parameters.

Thickener

Thickener performance is mainly a function of achievable solids concentration. The solids effluent will be sampled and tested for weight percent solids (targeted at approximately 50 percent). The thickener overflow water will also be sampled for clarity. The addition of polymer flocculation agents to the thickener feed, at various rates, will be tested to determine the reagent consumption for desired settling properties. (Tests have shown that the presence of the bentonite clay will make the thickener operation more difficult, requiring high levels of polymer and possibly pH adjustment. The ability to adequately thicken K-65 residues plus bentonite is crucial to the success of the Phase II program.)

Slurry Tanks

The alternating batch operation of the two agitated slurry tanks will be tested. The ability to substantially empty the slurry tank to the furnace before receiving the next batch from the thickener will be demonstrated.

The agitator blends the surrogate material and the additives so that a homogeneous mix is fed to the vitrification furnace. The slurry tanks will be sampled to ascertain the agitator's effectiveness and to determine the correct additive mix. Density in the slurry tanks will be monitored.

Vitrification Furnace

Furnace operation will be carefully monitored and adjustments to temperature, hold time, feed, etc., will be made as required to ensure an acceptable glass product. Operation of the melter at its lower temperature range coupled with the use of agitation will be tested to determine the minimum temperature required to produce an acceptable glass product. Of particular interest will be the effect of agitation on glass phase separation. Final product acceptance testing will include compression testing and TCLP analysis to determine leachability. Under certain operating conditions, metallic lead and other heavy metals may form and could settle to the bottom of the molten material within the furnace. Molten material at the furnace bottom will be drained from a low point and evaluated for the presence of metallic inclusions. The formation of metals is not anticipated from the vitrification process because the glass formulations are designed to preclude reducing conditions in the furnace so this activity is to monitor for and to confirm the absence of metals.

Temperature Control

The furnace is expected to operate between 1,050 and 1,400°C (1,922 - 2,552 °F). The ability to maintain a constant glass melt temperature during operations will be tested due to its importance to producing a uniform glass product that flows out of the furnace at a constant rate.

Foaming

Foaming occurs in a glass furnace by the release of gases that form at high temperature from the decomposition of feed materials - mostly carbon dioxide (CO_2) from carbonates. Because it is critical to be able to continuously operate the furnace without foaming problems, the extent of foaming will be observed by remote video monitoring and the glass formulation adjusted accordingly.

Molten Material Removal

Controlling the molten material flow from the furnace is important to the subsequent product forming operation. Testing will involve changing the flow rate to ensure that reasonable control of the level of molten material in the furnace can be maintained.

Product Forming

The product forming equipment will be a mechanical device which will cut the molten glass stream from the furnace into small pieces and cool the pieces in a controlled way to produce a product with acceptable physical (crush strength), chemical (leach resistance), and radiological (radon retention) properties. The operation and mechanical reliability of the system will be tested.

Quench Tower and Scrubber

The function of the quench tower and scrubber is to condense the water vapor from the furnace and remove any acid gases produced in the furnace. During testing, it will be monitored for pressure drop, water inventory control, and water temperature rise.

Off-gas Treatment System

The off-gas treatment system must be tested to demonstrate reliability and capability of handling the design throughput. It will consist of a dehumidification section (desiccant tower), a carbon bed adsorption section, and a final HEPA filtration section. During testing, the parameters to be monitored are the volumetric flow rate, the temperature and humidity of the air entering the carbon beds, the pressure drop through the system, and the radon removal efficiency. Radon concentration leaving the furnace and discharging through the stack will be measured and corrected for flow.

Cooling Tower

Cooling water will be needed to cool the water from the quench tower being recycled to the thickener and possibly the furnace electrodes and parts of the product forming equipment. Cooling towers are generally simple and reliable and require minimal attention. (Full-rate testing of the process in Phase I will verify that adequate cooling capacity exists in the cooling tower.) Treatment chemicals for the cooling tower water are: 1) phosphate, 2) calcium sulfate dispersant, and 3) chlorine.

Waste Water Treatment

The net amount of water removed from the process will exit mostly through the recycle water tank and the waste water filters. Suspended solids will be the only items requiring treatment in this water; therefore, treatment will consist only of a multimedia pressure filtration system. The ability to successfully handle the bentonite clay must be monitored. This process filtrate plus cooling tower blowdown and sink water will be discharged to the High Nitrate Tank which feeds the Biodenitrification system.

Distributed Control System

The control system will gather data from the vitrification operations for display on screens in the control room. Likewise, control devices [valves, dampers, Silicon Control Rectifiers (SCRs) for furnace electrodes] and motors will have their status displayed. Phase II operations will continue to test the reliability of this equipment and provide information on any deficiencies of the control scheme to be used for final remediation.

4.4.2 Planned Formulations:

K-65 and K-65/BentoGrout Mixtures

Initial testing will be on K-65 material slurried from Silo 1 or 2.

To the K-65 (or K-65/BentoGrout) material, add CaO and Na_2O such that:

$$\text{wt percent } Na_2O = 0.4 * \text{wt percent } Al_2O_3 + 5.0 \tag{1}$$
$$\text{wt percent } CaO = 2.0 * \text{wt percent } Na_2O \tag{2}$$

where:

the wt percent = the final value after mixing of the additives and waste.

The additives need not be in the oxide form, for example, sodium carbonate would be the likely additive to provide the soda.

K-65 and Silo 3 Mixtures

After successful vitrification of K-65 material, Silo 3 material will be introduced into the feed stream.

For every 100 grams of a dry mixture of K-65 (70 percent) and Silo 3 (30 percent) add:

Al_2O_3;	11.3 g
B_2O_3;	9.8 g
CaO;	5.6 g
Na_2O;	4.4 g

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TABLE 4-1

RECOMMENDED K-65/BENTOGROUT FORMULATION TEST MELTS WITH K-65 SIMULANT AND BENTOGROUT TREATABILITY SEQUENCES A AND B (WT PERCENT OXIDE CALCULATED FROM BATCH)

OXIDE	K-65/BG4	K-65/BG5	K-65/BG6	K-65/BG7
Al_2O_3	3.2	5.8	8.0	12.0
BaO	5.5	3.9	2.4	0.0
CaO	12.6	14.6	16.4	19.6
Fe_2O_3	4.2	3.7	3.4	2.7
K_2O	0.8	0.7	0.7	0.6
MgO	1.5	2.4	3.3	4.8
Na_2O	6.3	7.3	8.2	9.8
P_2O_5	0.7	0.8	0.9	1.1
PbO	10.7	7.6	4.8	0.0
SiO_2	54.7	53.2	51.8	49.5
Waste Loading Percent	83.9	81.2	78.7	74.5
Volume Expressed as a Multiple of the Initial Volume	0.39	0.41	0.43	0.47
Melt Temperature (°C)	1400	1400	1400	1400
Formulation Proportions (parts by dry mass)				
K-65	100	75	50	0
BG	0	25	50	100
CaO	10.4	12.9	15.5	20.7
Na_2O	4.4	5.4	6.3	8.2

TABLE 4-2

RECOMMENDED FORMULATION
FOR K-65/SILO 3 BLEND
TREATABILITY SEQUENCE D
(WT PERCENT OXIDE CALCULATED FROM BATCH)

OXIDE	D11
Al_2O_3	15.0
B_2O_3	10.0
BaO	3.3
CaO	7.8
Fe_2O_3	4.9
K_2O	1.0
MgO	3.9
Na_2O	7.1
P_2O_5	3.2
PbO	6.5
SiO_2	37.4
Waste Loading Percent	68.4
Volume Expressed as a Multiple of the Initial Volume	0.40
Melt Temperature (°C)	1350
Formulation Proportions (parts by dry mass)	
K-65	70.0
Silo 3	30.0
Al_2O_3	11.3
B_2O_3	9.8
CaO	5.6
Na_2O	4.4

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5.0 EQUIPMENT AND MATERIALS

Table 5-1 provides a preliminary list of equipment required to complete the Pilot Plant testing. Note that several of the items listed have been identified as existing at the FEMP Site (Detail: "Use on site equipment"), and the feasibility for their potential use is being investigated by FERMCO.

Equipment operations procedures and manufacturers requirements for preventative maintenance and calibration will be identified and controlled using FERMCO Maintenance Programs and Procedures. Equipment checks will be performed as required by the manufacturer or FERMCO operations, whichever applies, prior to initiating any operation of the Pilot Plant. Consideration for Health and Safety requirements will be identified in the Project Specific Health and Safety Plan that is required for Phase II Pilot Plant operation.

LEGEND
4 - SILO EQUIPMENT
5 - VIT FACILITY EQUIP.

TABLE 5-1

NOTE: ARO = After Receipt of Order
D.S. = Data Sheet only
BOLD = Delayed until further notice

CRU4 PILOT PLANT PROGRAM – PHASE 1 AND 2
EQUIPMENT LIST
MATERIAL RETRIEVAL AND VITRIFICATION

EQUIP NO.	DESCRIPTION	QTY	HP	SPEC. NO.	DESIGN CAPACITY	ON SITE EQ. CAPACITY	REQ. NO.	WEIGHT (#)	SPEC. RESPONS.	DETAIL	VENDOR
4-PM-02	Silo 4 Residue Removal Package	1	10	01-40-002	75 GPM		109413		FERMCO		FERMCO
4-HS-03	Chain Hoist (Pump Maint.)(ER-Silo 4)	1		14613	2 TON				FERMCO		FERMCO
4-WN-04	Electric Winch (Hoist) (ER-Silo 4)	1	20	18-TS-320	5 TON		109453		FERMCO		FERMCO
4-HS-07	Chain Hoist (Silo Door)(ER-Silo 4)	2		14613	1/4 Ton				FERMCO		Subcontractor
4-IN-11	Silo Insert (Silo 4)	1		14612	7' Dia, 3'-4" L				Parsons		Subcontractor
4-WN-19	Hand Winch (S.S.-Silo 4)	1		14613	500 LB				FERMCO		Subcontractor
4-CA-21	Maintenance Carriage (ER-Silo 4)	1		14612	6000 LB				Parsons		Subcontractor
4-CN-20	Monorail Hoist w/ Trolley (ER-Silo 4)	1	15	18-TS-320	5 TON		109453		FERMCO		FERMCO
4-CM-08A,B	Silo Camera	2							Parsons	Rev. A only. Use on site equipment	
4-FA-35	Exhaust Fan (Silo 4)	1	1	18-TS-125	2050 CFM, 0.75" WG		115394		Parsons		FERMCO
4-FA-36	Exhaust Fan (ER-Silo 4)	1	1.5	18-TS-125	3000 CFM, 0.5" WG		115394		Parsons		FERMCO
4-DP-37	Intake Air Damper (ER-Silo 4)	1			48" X 48", 2450 CFM				FERMCO	D.S. only.	Subcontractor
4-GA-39	Silo Door (Silo 4)	1		14612					Parsons		Subcontractor
4-PM-01	Pilot Plant Silo Residue Removal Pump	1	5	02-40-001	50 GPM		109451		FERMCO		FERMCO
4-RN-06	**Carbon Bed Vessels (RTS Bleed-off)**	**5**		**01-40-006**	**100 CFM**				**FERMCO**		**FERMCO**
4-FA-10	RTS Fan	1	25	N/A	1000 CFM	1000 cfm, 39" WC			FERMCO	Existing on site equipment	
4-DH-12	**Desiccant Tower (RTS)**	**1**		**18-TS-312**	**1100 CFM**				**FERMCO**	**Parsons prepared Data Sheets (PO85)**	**FERMCO**
4-PM-13	**Desiccant Tower Pump (RTS)**	**1**	**(1/3)**	**18-TS-312**	**10 GPM (5 gpm)**				**FERMCO**	**Parsons prepared Data Sheets (PO85)**	**FERMCO**
4-FL-14 A,B	**HEPA Filter (RTS Bleed-off) (1 inst. spa**	**2**		**18-TS-148**	**200 CFM**				**Parsons**	**Spec. under PO-85**	**FERMCO**
4-XS-15	**Exhaust Stack (RTS Bleed-off)**	**1**		**15500**	**200 CFM**				**Parsons**	**Spec. under PO-85**	**FERMCO**
4-FA-16	**Silo Offgas Fan (RTS Bleed-off)**	**1**			**200 CFM**				**FERMCO**		**FERMCO**
4-RN-17 A-H	RTS Carbon Beds	8		N/A	500 CFM each	500 CFM each			FERMCO	Existing on site equipment	
4-DH-18 A,B	RTS Calcium Sulfate Beds	2		N/A	500 CFM each	500 CFM each			FERMCO	Existing on site equipment	
4-DC-27	Filter/Receiver (Silo 3)	1		14500	6383 LB/HR		109455		Parsons		FERMCO
4-BN-29	Silo 3 Surge Bin	1		18-TS-101	400 cu ft				Parsons		FERMCO
4-VC-30	Vacuum Nozzle (Silo 3)	1		14500	3" Dia, 40' L		109455		Parsons		FERMCO
4-RV-32	Rotary Airlock (Silo 3 Surge Bin)	1	1.5	14501	6000 LB/HR, 8"		109455		Parsons		FERMCO
4-GA-33	Slide Gate (Silo 3 Surge Bin)	1		14500	6000 LB/HR, 12"		109455		Parsons		FERMCO
4-RV-34	Rotary Airlock (Silo 3 Filter/Receiver)	1	1.5	14500	6383 LB/HR, 8"		109455		Parsons		FERMCO

TABLE 5-1

LEGEND
4 - SILO EQUIPMENT
5 - VIT. FACILITY EQUIP

NOTE: ARO = After Receipt of Order
D.S. = Data Sheet only
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CRU4 PILOT PLANT PROGRAM – PHASE 1 AND 2
EQUIPMENT LIST
MATERIAL RETRIEVAL AND VITRIFICATION

EQUIP NO.	DESCRIPTION	QTY	HP	SPEC. NO.	DESIGN CAPACITY	ON SITE EQ. CAPACITY	REQ. NO.	WEIGHT (#)	SPEC. RESPONS.	DETAIL	VENDOR
5-TK-01	Thickener Tank	1		18-TS-101	20,000 GAL, 3' S/S				Parsons (D.S.)	14 wks ARO to site	FERMCO
5-TH-02	Thickener Mechanism and Rakes	1	5	18-TS-102	30 FT. DIA.		109410		FERMCO	Parsons prepared Data Sheets	FERMCO
5-FL-03A,B	Waste Water Filter	2			10 GPM	10 GPM			Parsons (D.S.)	Use on site equipment	
5-PM-04A,B	Thickener Underflow Pump (1 installed spare)	2		02-40-004	40 GPM @ 33 psi		109421	181	FERMCO	Parsons prepared Data Sheets	FERMCO
5-AG-05A	Slurry Tank Agitator (for 5-TK-29A)	1	5	18-TS-105			109448		FERMCO	Parsons prepared Data Sheets	FERMCO
5-AG-05B	Slurry Tank Agitator (for 5-TK-29B)	1	5	18-TS-105			109448		FERMCO	Parsons prepared Data Sheets	FERMCO
5-SB-07/22	Quench Tower and Scrubber System	1		02-40-007/022	120 CFM		109423		FERMCO	Parsons prepared Data Sheets	FERMCO
5-PM-09A,B	Recycle Water Pump (1 installed spare)	2	75 (30)	02-40-009	130 GPM (90 gpm)		109438	1515	FERMCO	Parsons prepared Data Sheets	FERMCO
5-TK-10	Recycle Water Tank	1		18-TS-101	5,800 GAL				Parsons (D.S.)		FERMCO
5-FU-17	Vitrification Furnace	1		02-40-062	1 TONNE/DAY		109420		Parsons		FERMCO
5-VL-18	Diverter Valve (Additives)	1		18-TS-165	6000 LB/HR, 8"		109445		Parsons		FERMCO
5-RN-19A,B	Carbon Bed Vessel (Vitrification Offgas)	2		02-40-019	250 CFM		109417		FERMCO		FERMCO
5-XS-20	Exhaust Stack	1		15500	6600 CFM				Parsons		Subcontractor
5-DH-21	Desiccant Tower w/ Pump	1	(1/3)	02-40-021	250-500 cfm, 10 gpm		109418		FERMCO	Parsons prepared Data Sheets	FERMCO
5-PM-23A,B	Quench Tower Pump (1 installed spare)	2	3	02-40-009	60 GPM (40 gpm)		109438	500	FERMCO	Parsons prepared Data Sheets	FERMCO
5-BF-24	Product Forming Machine	1	2	18-TS-163	1 TONNE/DAY		109431		FERMCO	14 wks ARO to site	FERMCO
5-FA-25	Exhaust Fan (Vitrification Offgas)	1	10 (2)	18-TS-125	250-500 cfm (237 cfm)		115394		FERMCO	Parsons prepared Data Sheets	FERMCO
5-CT-26	Cooling Tower	1	5 (10)	18-TS-126	200 GPM		109440		FERMCO		FERMCO
5-HE-27	Heat Exchanger	1		18-TS-127	2 E6 BTU/HR		109444		FERMCO	Parsons prepared Data Sheets	FERMCO
5-PM-28	Cooling Tower Pump (1 non-installed spare)	2	10 (15)	02-40-009	220 GPM (200 gpm)		109438	641	FERMCO	Parsons prepared Data Sheets	FERMCO
5-TK-29A	Slurry Tank (Vitrification)	1		18-TS-101	700 GAL				Parsons (D.S.)		FERMCO
5-TK-29B	Slurry Tank (Vitrification)	1		18-TS-101	700 GAL				Parsons (D.S.)		FERMCO
5-TF-30	Transformer	1				2000 KVA			FERMCO	Use on site equipment	
5-SG-31	Medium Voltage Switchgear	1				600 Amp			FERMCO	Use on site equipment	
5-SG-32	Low Voltage Switchgear	1				3200 Amp			FERMCO	Use on site equipment	
5-MC-33A,B	Motor Control Center	2			600 AMP	600 Amp			FERMCO	Use on site equipment	
5-PM-34A,B	Slurry Tank Pump (for 5-TK-29A,B)	2		02-40-004	40 GPM @ 40 psi		109421	181	FERMCO	Parsons prepared Data Sheets	FERMCO
5-FC-40	Flocculant Additive System	1	3 (1)	02-40-040	1.2 GPM, 200 Gal	0-5 gpm, 200 gal			FERMCO	Use on site equipment	
5-CN-41	Furnace Room Monorail Hoist	1		18-TS-320	2 Ton		109453		FERMCO		FERMCO
5-GE-43	Emergency Generator	1		02-40-043	150 KW		109436		FERMCO	16 wks ARO to site	FERMCO
5-CM-44	Air Compressor Package System	1	60	18-TS-144	220 CFM @100 psi		109437		FERMCO	Parsons prepared Data Sheets	FERMCO
5-BH-46	Drum Hdlg. Station (Final Product)	1		18-TS-146	1 TONNE/DAY		109442		Parsons		FERMCO
5-CS-47	Data Acquisition and Control System	1			400 POINTS	1200 POINTS			FERMCO	Use on site equipment	
5-FL-48A,B	HEPA Filter (Vit. Offgas)(1 installed spare)	2		18-TS-148	250-500 cfm (237 cfm)		109443		FERMCO		FERMCO
5-PM-50A,B	Building Sump Pump (1 installed spare)	2	5 (1)		25 GPM	30 GPM			Parsons (D.S.)	Use on site equipment	
5-TK-56	Spare Storage Tank	1		18-TS-101	20,000 GAL				Parsons (D.S.)		FERMCO
5-PM-57	Spare Storage Tank Pump	1		18-TS-157	90 GPM @45 psi		109441		FERMCO	Parsons prepared Data Sheets	FERMCO
5-PM-58	Tank Pad Containment Sump Pump	1	5 (3/4)		25 GPM	30 OR 100 GPM			Parsons (D.S.)	Use on site equipment	
5-PM-60	Caustic Metering Pump	1	0.5	18-TS-160	1.5 GPM		109419		Parsons (D.S.)		FERMCO
5-BG-64	Bag Dump Station w/ Filter (Additives)	1	0.5	18-TS-165	6000 LB/HR		109445		Parsons		FERMCO
5-DC-65	Filter/Receiver (Additives)	1		18-TS-165	6000 LB/HR		109445		Parsons		FERMCO
5-BL-66	Portable Vacuum Blower w/ HEPA	1	10	18-TS-165	350 SCFM		109445		Parsons		FERMCO
5-PO-69	U.P.S. (DACS)	1		02-40-069	12.5 KVA		109446		FERMCO		FERMCO
5-PM-[illegible]	*Containment Sump Pump (Thickener)*	*1*		*18-TS-157*	*90 GPM @45 psi*		*109441*		*FERMCO*		*FERMCO*
5-RV-[illegible]	Rotary Airlock (Additives Filter/Receiver)	1	1.5	18-TS-165	6000 LB/HR, 8"	~~6000 LB/HR~~	109445		Parsons		FERMCO

LEGEND-
4 = SILO EQUIPMENT
5 = VIT. FACILITY EQUIP

TABLE 5-1

NOTE: ARO = After Receipt of Order
D.S. = Data Sheet only
BOLD = Delayed until further notice

CRU4 PILOT PLANT PROGRAM – PHASE 1 AND 2
EQUIPMENT LIST
MATERIAL RETRIEVAL AND VITRIFICATION

EQUIP NO.	DESCRIPTION	QTY	HP	SPEC. NO.	DESIGN CAPACITY	ON SITE EQ. CAPACITY	REQ. NO.	WEIGHT (#)	SPEC. RESPONS.	DETAIL	VENDOR
5-SC-72	Platform Scale (Additives)	1		14501	400 LB				Parsons	Use on site equipment	
5-VL-73	Diverter Valve (Silo 3 material)	1		14501	6000 LB/HR, 8"		109455		Parsons		FERMCO
5-SU-74	Building Sump Tank	1		18-TS-101	700 GAL				FERMCO	Parsons prepared Data Sheets	FERMCO
5-VL-75	Diverter Valve (pneumatic transfer sys.)	1		18-TS-165	3"		109445		Parsons		FERMCO
5-AU-76	Make-Up Air Handling Unit	1	7.5	15781	3200 CFM				Parsons		Subcontractor
5-AC-77	Air Conditioning Unit – Computer Room	1	0.5	15786	1250 CFM				Parsons		Subcontractor
5-AC-78	Air Conditioning Unit – Computer Room	1	0.5	15786	1250 CFM				Parsons		Subcontractor
5-AU-79	Heating & Ventilation – Air Handling Unit	1	3	15855	1480 CFM				Parsons		Subcontractor
5-CB-80	Condensing Unit	1	0.2	15671	3 Ton				Parsons		Subcontractor
5-CB-81	Condensing Unit	1	0.2	15671	3 Ton				Parsons		Subcontractor
5-FA-82	Exhaust Fan – Centrifugal Blower	1	30 (20)	15860	6000 CFM	6000 CFM			Parsons	Use on site equipment	
5-FA-83	Exhaust Fan – Wall Mounted	1	<1	15860	150 CFM				Parsons		Subcontractor
5-FA-84	Exhaust Fan – Roof Mounted	1	3	15860	15,000 CFM				Parsons		Subcontractor
5-FL-85A,B	HEPA/MEPA Filters (Building HVAC)	2			6000 CFM	6000 CFM			Parsons	Use on site equipment	
5-HT-86	Duct Heater	1	53 kw	15500	3200 CFM				Parsons		Subcontractor
5-HT-87	Duct Heater	1	21 kw	15500	1480 CFM				Parsons		Subcontractor
5-HT-88	Unit Heater	1	15 kw	15500	1100 CFM				Parsons		Subcontractor
5-HT-89	Unit Heater	1	15 kw	15500	1100 CFM				Parsons		Subcontractor
5-HT-90	Unit Heater	1	7.5 kw	15500	700 CFM				Parsons		Subcontractor
5-AT-92A,B	Bin Vibrator (4-BN-29)	2		18-TS-101					Parsons		FERMCO
5-DP-93	*Barometric Damper*	*1*		*15500*	*24" X 36", 2000 CFM*				*FERMCO*	*D.S. only*	*Subcontractor*
5-VN-94	*Gravity Ventilator (Roof)*	*1*		*15500*	*15,000 CFM*				*Parsons*		*Subcontractor*
5-TK-95	*Utility Tank*	*1*			*300 GAL*				*Parsons (D.S.)*		*Subcontractor*

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6.0 SAMPLE AND ANALYSIS MANAGEMENT

Sampling described in this CRU4 Work Plan is to support waste retrieval and treatability study testing of the vitrification of the K-65 Silos and Silo 3 materials, which is presented as a potential remedial engineering alternative in the CRU4 Feasibility Study Report.

The Sitewide CERCLA Quality Assurance Project Plan (SCQ) does not describe Sample Collection Logs for work performed under Treatability Studies. CRU4 will develop Collection Logs for sampling activities identified in Tables 6-1 and 6-2 (see Pages 6-2 thru 6-12) of this Work Plan. The logs will number the sample collected, the sampling point, the date and time of collection and other sampling information necessary to identify and track the sample. Sample custody will be in accordance with requirements of the SCQ. Sample analysis reports will be generated, validated, assessed, and reported as required to support the Final Report requirements of Section 12.0.

6.1 SAMPLING OBJECTIVES

Pilot Plant sampling will:

A. Provide data for scaling up the process, using K-65 and Silo 3 materials for feed.

B. Determine the correct additive requirements.

C. Establish the full-scale operating parameters.

D. Establish the final waste form (gems or monolith).

E. Finalize quality acceptance criteria of the vitrified final product.

F. Provide for the testing of wastes and residuals from the process for determining compliance with the project's site environmental programs.

Based on test objectives presented in Section 3.0 and the process design described in Section 4.0, this section describes all sampling and analysis which will be used to evaluate and control the Pilot Plant operations. Table 6-1 summarizes the Sampling and Analysis Plan (SAP) developed for the overall CRU4 Pilot Plant Phase II Study. For each sampling matrix, the table outlines the sampling parameters, rationale, sampling methodology, sampling frequency, sample preparation, analytical methodology, Analytical Support Level (ASL), and Quality Assurance (QA) requirements. Process control parameters which are discussed in Section 4.0 and characterization parameters are both presented in Table 6-1. Sampling locations are presented in Figure 4-2, CRU4 Pilot Plant Process Flow Diagram - Phase II.

Table 6-1 CRU4 Pilot Plant Sampling and Analysis Plan

Parameter	Rationale/Objective	Sampling Methodology	Frequency	Sample Preparation	Analytical Methodology[1]	ASL	QA Samples
1. Waste Water Filter Effluent (S1)							
Radionuclides See Footnote b	Determine the inputs to the water treatment system	Grab sample of 6 liters required for analysis	One per run	Preservation Nitric Acid ph<2.	ICP - SCQ Appendix G Table G-4 Offsite Laboratory	B	SCQ - Section 4 Table 2-2 [2] Table 2-4
Heavy Metals See Footnote c	Determine the inputs to the water treatment system	Grab sample of 3 liters required of analysis	One per run	Per Method	DCP, ICPMS SW846-6010, 7060, 7460, & 7761 Offsite Laboratory	B	SCQ - Section 4 Table 2-2 [2] Table 2-4
Total Suspended Solids	Determine the inputs to the water treatment system	Grab sample of 500 milliliters (ml) required for analysis	One per run	Per Method	FERMCO Lab EPA Standard 160.2 or 2540D	B	SCQ - Section 4 Duplicate
2. Sludge/Slurry Line from Silo to Thickener (S2)							
Percentage of Solids Total	Measure slurry machine performance	Grab sample of 250 ml required for analysis	One per batch	Per Method	EPA Standard Method 160.3 Onsite Lab	B	SCQ-Section 4 Duplicate
3. Sludge/Slurry Line from Thickener to Slurry Tanks (S3)							
Percentage of Solids Total	Measure thickener performance	Grab sample of 250 ml required for analysis	1-10 per run as needed	Per Method	EPA Standard Method 160.3 Onsite Lab	B	SCQ-Section 4 Duplicate
4A. and 4B. Sludge/Slurry Tank Sampling Port (S4A & S4B)							
Anions (Fluoride, Sulfate/Phosphate, Chloride, and Nitrate)	To quantify components affecting glass/melt properties and to determine additives to reach target feed composition	Grab sample of 3 liters required for analysis	Once per tank batch	Per Method	EPA Standard Methods 325.2, 300.all, 340.2, 353.1, 365.all, 375.2 Onsite Lab	B	Sample field per lab method [2]
Total Organic Carbon (TOC)	Impact of organics on glass redox	Grab sample of 250 ml required for analysis	Once per tank batch	Per Method	SW-846-9060	B	Sample field per lab method
Radionuclides See Footnote b	To determine radionuclide constituents and to determine additives to reach target feed composition	Grab sample of 6 liters required for analysis.	Once per tank batch	Solution removed from sludge Preservation Nitric Acid ph<2.	ICP-SCQ Appendix G Table G-4 Offsite Lab	C	SCQ - Section 4 Table 2-2 [2] Table 2-4

Table 6-1 CRU4 Pilot Plant Sampling and Analysis Plan

Parameter	Rationale/Objective	Sampling Methodology	Frequency	Sample Preparation	Analytical Methodology[1]	ASL	QA Samples
Wet Density	Feed System development	Grab sample of 250 ml of sludge will be transferred from the feed blending station sampling port to an appropriate container for specified analyses.	Once per tank batch	None - received wet	Weight, volume - SCQ - Appendix G	B	None
Percent Solid (Moisture)	Feed System development & to determine additives to reach target feed composition	Grab sample of 250 ml required for analysis	Once per tank batch	Per method	EPA Standard Method 160.3	B	Duplicate
Sieve Analysis	Feed System development	Grab sample of 250 ml required for analysis	Once per tank batch	None	ASTM-D422-63	A	Duplicate
Weight	To determine weight loss versus temperature	Grab sample of 250 ml required for analysis	Once per tank batch	None	ASTM-D421	A	Duplicate
5. Slurry/Furnace Feed Line (S5)							
Percentage of Solids Total	To measure furnace feed uniformity	Grab sample of 250 ml required for analysis	One per feed batch	Per Method	EPA Standard Method 160.3	B	Duplicate
6. Quench Tower Water/Quench Tower to Thickener Recycle Line (S6)							
Chemical composition See Footnote a	To determine quantities to be added to vitrification feed make up tank to reach target feed composition	Grab sample of 2 liters required for analysis	One per feed batch	Per Method	ICP-GFAA-AA Offsite lab SW-846-7000, 6010, 7470	B	Field blank DI water, duplicate
7. Scrubber Reagent/Scrubber Sample Port (S7)							
Total Dissolved Solids	To determine salt content in the sump - for process control	Grab sample of 250 ml required for analysis	One per batch or shift	Per Method	EPA Standard Method 160.1 or 2540	B	Duplicate
Alkalinity	To determine reagent consumption-for process control	Grab sample of 250 ml required for analysis	One per shift	None	Titration EPA Standard Method 310.1 or 2320B	B	None
8. Melter (S9)							
Melter Refractory and electrode dimensions and condition	To provide baseline data for "before and after" materials performance evaluation - for process control	in situ	≥5 per campaign	None	Photographs, visual inspection, & calipers	A	None
Lid temperature	Melter performance - for process control	in situ	Hourly	None	Thermocouple	A	None
Discharge temperature	To ensure glass liquidity - for process control	in situ	Hourly	None	Thermocouple	A	None

Table 6-1 CRU4 Pilot Plant Sampling and Analysis Plan

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Parameter	Rationale/Objective	Sampling Methodology	Frequency	Sample Preparation	Analytical Methodology[1]	ASL	QA Samples
Differential pressure to off-gas	Off-gas system performance, ensure negative pressure in melter - for process control	in situ	Hourly	None	Pressure gauge	A	None
Pressure (Melter head space)	Off-gas system performance - for process control	in situ	Hourly	None	Pressure gauge	A	None
Bottom drain temperature	Melter performance - for process control	in situ	As required	None	Thermocouple	A	None
Melt temperature distribution	To determine melt pool temperature in various locations and ensure within operating ranges - for process control	in situ	Continuous monitoring	None	Thermocouple	A	None
Electrical parameters	To determine power input to glass melt; ensure parameters within operating ranges - for process control	in situ	Continuous monitoring	None	Ammeters & voltmeters	A	None
Cold cap extent	To control feed rate to melter - for process control	None	Continuous monitoring	None	Visual observation by operator	A	None
9. Glass gems (or molten glass sample if a monolith is being cast)/Feed chute to glass product storage (S10)							
Chemical composition See Footnote c	To obtain measure of leachability and to compare the mobility/toxicity reduction of the completed feed batch and the glass gems	Grab sample of 1 liter required for analysis. Sample will be split between TCLP and PCT sample preparation.	Once per vitrification run.	TCLP	EPA Standard Method-1311	B	Duplicate MSD
Chemical composition See Footnotes b & c	To determine long-term durability and to compare the mobility/toxicity reduction of the completed feed batch and the glass gems	Grab sample of 1 liter required for analysis. Sample will be split between TCLP and PCT sample preparation.	Once per vitrification run.	Water leachate from the glass sample will be collected at 7, 14, 28, 56, and 180 days	EPA - Simulated Leachate Rainwater Procedure (SLRP)	B	Duplicate
Chemical composition See Footnotes b & c	To compare with high-level waste glass performance data obtained in other studies and to compare the mobility/toxicity reduction of the completed feed batch and the glass gems	Grab sample of 1 liter required for analysis. Sample will be split between TCLP and PCT sample preparation.	2 of the retained samples will be selected for analyses	At 90 °C, water leachate from the glass sample will be collected at 7, 14, 28, 56, and 180 days	EPA - SLRP	B	Duplicate
Crystal Structure	To determine extent and type of devitrification	Grab sample of 250 ml of glass gems will be collected from the feed chute, cooled, and transferred to an appropriate container for specified analyses.	1 per 6 hours feeding	None	Scanning Electron Microscopy (SEM)-EDX	A	Duplicate

Table 6-1 CRU4 Pilot Plant Sampling and Analysis Plan

Parameter	Rationale/Objective	Sampling Methodology	Frequency	Sample Preparation	Analytical Methodology[1]	ASL	QA Samples
Density	To provide data for storage/movement	Grab sample of 250 ml of glass gems will be collected from the feed chute, cooled, and transferred to an appropriate container for specified analyses.	1 per 6 hours feeding	Per Method	ASTM-C693-84	B	Duplicate
Redox state	To determine glass redox state	Grab sample of 250 ml of glass gems will be collected from the feed chute, cooled, and transferred to an appropriate container for specified analyses.	1 per 6 hours feeding	Per Method	Mossbauer spectroscopy - ASTM-1498	A	Duplicate
Viscosity	To determine melt viscosity versus temperature - for process control	Grab sample of 250 ml of glass gems will be collected from the feed chute, cooled, and transferred to an appropriate container for specified analyses.	1 per day while feeding	Remelt glass	Melt Viscosity	A	Duplicate
Electrical Conductivity	To determine melt conductivity versus temperature - for process control	Grab sample of 250 ml of glass gems will be collected from the feed chute, cooled, and transferred to an appropriate container for specified analyses.	1 per day while feeding	Remelt glass	EPA Standard Method 120.1 or 2510B	A	Duplicate
Radon Emanation	To determine radon emanation rate from product gems	Grab sample of 250 ml of glass gems will be collected from the feed chute, cooled, and transferred to an appropriate container for specified analyses.	1 per day while feeding	None	Custom - radon emanation	A	None
Radiation Dose	To determine radiation dose at the surface and near the final waste form	As produced	One per day while feeding	None	Health Physics technicians survey final waste form package	A	None
Glass output/mass balance	To determine glass production rates; system performance and mass balance	As produced	As produced	None	Accumulated weight measurement log	A	None
Volume	To determine overall volume reduction	None	One per drum	None	Weigh drum	A	None

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Table 6-1 CRU4 Pilot Plant Sampling and Analysis Plan

Parameter	Rationale/Objective	Sampling Methodology	Frequency	Sample Preparation	Analytical Methodology[1]	ASL	QA Samples
10. Off-gas/Before quench tower (S11)							
Particulate composition See Footnote b & c	To determine concentrations of selected components in off-gas stream	40 CFR 60, Appendix A, Method 5	One time sample event	None	DCP, γ-Spectrometry - SCQ Appendix G	C	Field blank Unused bottle solutions 1 in 10, duplicate γ-Spectrometry - SCQ Section 4
Gas composition - Carbon Monoxide - Carbon Dioxide - Sulfur Dioxides - Nitrogen Oxides - Hydrogen Chloride - Total Fluorides - Beryllium - Total Organic Carbon - Organics - Radon-222	To determine concentrations of selected components in off-gas stream	All sample Methods per 40 CFR 60, Appendix A unless otherwise noted. CO - Method 10 or 10B CO_2 - Method 3 or 3A SO_2 - Method 6 or 6C NO_x - Method 7 or 7E HCl - Method 26 F - Method 13A or 13B Be - 40 CFR Part 61 Appendix B Method 104 TOC - Method 25 or 25A Organics - Method 18 Radon-222 - 40 CFR 61, Appendix B, Method 115	One time sample event	None	Analysis per EPA Method identified in the Sampling Methodology column except as note below: Be - 40 CFR 60, Appendix A, Method 104 Radon-222 - 40 CFR 61, Appendix B, Method 114 (A-6)	C	Duplicate [2]
Off-gas flow rate	To determine flow rate for calculation of emission rate - for process control	In situ - 40 CFR 60, Appendix A, Method 2	Continuous monitoring	None	Flow meter with temperature correction	B	None
Temperature and pressure differentials across all system components	To assure compliance with Original Equipment Manufacturer's (OEM) specifications and VSL-SOP; for maintenance and process control	In situ	Continuous monitoring	None	Thermocouple & differential pressure gauge	B	None
11. Treated Off-gas/Before discharge to atmosphere (S12)							
Particulate composition See Footnotes b and c	To determine concentrations of selected components in off-gas stream and comply with 40 CFR 61 Subpart H	40 CFR 60, Appendix A, Method 5	One per batch	None	SCQ Appendix G GFAA Radiochemistry - Alpha Spectrometry per 40 CFR 61 Appendix B, Method 114	C	Field blank Unused bottle solutions 1 in 10, duplicate γ-Spectrometry - SCQ Section 4

Table 6-1 CRU4 Pilot Plant Sampling and Analysis Plan

Parameter	Rationale/Objective	Sampling Methodology	Frequency	Sample Preparation	Analytical Methodology[1]	ASL	QA Samples
Gas composition - Carbon Monoxide - Carbon Dioxide - Sulfur Dioxides - Nitrogen Oxides - Hydrogen Chloride - Total Fluorides - Beryllium - Total Organic Carbon - Organics - Radon-222	To determine concentrations of selected components in off-gas stream	All sample Methods per 40 CFR 60, Appendix A unless otherwise noted. CO - Method 10 or 10B CO_2 - Method 3 or 3A SO_2 - Method 6 or 6C NO_x - Method 7 or 7E HCl - Method 26 F - Method 13A or 13B Be - Method 5 TOC - Method 25 or 25A Organics - Method 18 Radon-222 - 40 CFR 61, Appendix B, Method 115	One time sample event	None	Analysis per EPA Method identified in the Sampling Methodology column except as note below: Be - 40 CFR 60, Appendix A, Method 104 Radon-222 - 40 CFR 61, Appendix B, Method 114 (A-6)	B	Duplicate [2]
Off-gas flow rate	To determine flow rate for calculation of emission rate - for process control	In situ - 40 CFR 60, Appendix A, Method 2	Continuous monitoring	None	Flow meter with temperature correction	B	None
Temperature and pressure differentials across all system components	To assure compliance with OEM specifications and VSL-SOP; maintenance and process control	In situ	Continuous monitoring	None	Thermocouple & differential pressure gauge	B	None
12. Recycle water/Recycle water line to Quench Tower (S14)							
Percentage of Suspended Solids	To determine effectiveness of Thickener	Grab sample of 1 liter required for analysis.	One per shift	Per Method	Standard EPA Method 160.2 or 2540B	B	Duplicate sample
Percentage of Dissolved Solids	To determine buildup of soluble salts in the recycle loop	Grab sample of 1 liter required for analysis.	One per shift	Per Method	Standard EPA Method 160.1 or 2540C	B	Duplicate sample
pH	To determine the pH	Grab sample of 1 liter required for analysis.	One per shift	None	Standard field pH measurement	A	None
13. Cooling Tower Water/Cooling Tower Water Line (S15)							
Percentage of Dissolved Solids	To determine buildup of soluble salts in the cooling tower water to determine blowdown rate	Transfer of sample to an appropriate container	One per week	Per Method	Standard EPA Method 160.1 or 2540C	B	Duplicate sample
Water Chemistry	To determine proper amount of treatment chemicals	Transfer of sample to an appropriate container	One per week	None	Performed by vendor of treatment chemicals	B	Duplicate sample

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Table 6-1 CRU4 Pilot Plant Sampling and Analysis Plan

Parameter	Rationale/Objective	Sampling Methodology	Frequency	Sample Preparation	Analytical Methodology[1]	ASL	QA Samples
14. Thickener Overflow (S16)							
Percentage of Suspended Solids	To determine effectiveness of Thickener	Grab sample of 500 ml required for analysis	One per shift	Per Method	Standard EPA Method 160.2 or 2540D	B	Duplicate sample
Percentage of Dissolved Solids	To determine buildup of soluble salts in the recycle loop	Grab sample of 500 ml required for analysis	One per shift	Per Method	Standard EPA Method 160.1 or 2540C	B	Duplicate sample
15. Building Sump Effluent (S17)							
Radionuclides See Footnote b	Determine the inputs to the water treatment system	Grab sample of 6 liters required for analysis	One per run	Preservation Nitric Acid pH<2	ICP - SCQ Appendix G Table G-4 Offsite Lab	B	SCQ - Section 4 Table 2-2 [2] Table 2-4
Heavy Metals See Footnote c	Determine the input to the water treatment system	Grab sample of 3 liters required for analysis	One per run	Per Method	DCP, ICPMS SW846-6010, 7060, 7761, 7470 Offsite Lab	B	SCQ - Section 4 Table 2-2 [2] Table 2-4
Total Suspended Solids	Determine the inputs to the water treatment system	Grab sample of 500 ml required for analysis	One per run	Per Method	FERMCO lab EPA Standard Method 160.2 or 2540D	B	SCQ - Section 4 Duplicate

a Analytes include Al, B, Ba, Ca, Fe, K, Li, Mg, Na, Si
b Analytes include ^{227}Ac, ^{210}Bi, ^{231}Pa, ^{210}Pb, ^{210}Po, ^{223}Ra, ^{226}Ra, ^{99}Tc, ^{227}Th, ^{228}Th, ^{230}Th, ^{232}Th, ^{234}Th, ^{234}U, ^{235}U ^{238}U
c Analytes include Ag, As, Ba, Cd, Cr (Hexavalent), Hg, Pb, Se; may also include Al, B, Ca, Fe, Mg, Mn, Na, Si, U

(1) Analytical Methodologies labeled SCQ are found in the *Sitewide CERCLA Quality Assurance Project Plan* (DOE 1992b).

(2) Quality Control requirements such as instrument calibration and method blanks are specified as part of the analytical methodology.

Table 6-2 CRU4 Pilot Plant Sampling Goals

Parameter	DRIVER	GOAL/COMMENTS
1. Waste Water Filter Effluent (S1)		
Radionuclides See Footnote b	NPDES Permit OAC3745-1-07	Must meet site wastewater treatment acceptance criteria.
Heavy Metals See Footnote c	NPDES Permit OAC3745-1-07	Must meet site wastewater treatment acceptance criteria.
Total Suspended Solids	Process Design	For information only. Needed for full-sized facility design.
2. Sludge/Slurry Line from Silo to Thickener (S2)		
Percentage of Solids Total	Process Design	20% w/o. Need for full-sized facility design.
3. Sludge/Slurry Line from Thickener to Slurry Tanks (S3)		
Percentage of Solids Total	Process Design	50% w/o. Needed for full-sized facility design.
4A. and 4B. Sludge/Slurry Tank Sampling Port (S4A & S4B)		
Anions (Fluoride, Sulfate/Phosphate, Chloride, and Nitrate)	Process Control	For information only. Needed to adjust recipe.
Total Organic Carbon (TOC)	Process Control	For information only. Needed to adjust recipe.
Radionuclides See Footnote b	Process Control	For information only. Needed to adjust recipe.
Wet Density	Process Design	Needed for full-sized facility design.
Percent Solid (Moisture)	Process Control	For information only. Needed for process control.
Sieve Analysis	Process Design	For information only. Needed for equipment design.
Weight	Process Design	For information only. Needed for process control.
5. Slurry/Furnace Feed Line (S5)		
Percentage of Solids Total	Process Control	60% For information only. Needed for process control.
6. Quench Tower Water/Quench Tower to Thickener Recycle Line (S6)		
Chemical composition See Footnote a	Process Control	For information only. Needed for process control.
7. Scrubber Reagent/Scrubber Sample Port (S7)		
Total Dissolved Solids	Process Design	For information only. Needed for full-sized facility design.
Alkalinity	Process Control	Needed to determine reagent consumption.
8. Melter (S9)		
Melter Refractory and electrode dimensions and condition	Process Design	For information only. Needed for full-sized facility design.
Lid temperature	Process Control	For information only. Needed for full-sized facility design.
Discharge temperature	Process Control	For information only. Needed for process control.

Table 6-2 CRU4 Pilot Plant Sampling Goals

		DRIVER	GOAL/COMMENTS
Parameter			
Differential pressure to off-gas		Process Control	For information only. Needed for process control.
Pressure (Melter head space)		Process Control	For information only. Needed for process control.
Bottom drain temperature		Process Control	For information only. Needed for process control.
Melt temperature distribution		Process Control	For information only. Needed for process control.
Electrical parameters		Process Control	For information only. Needed for process control.
Cold cap extent		Process Control	For information only. Needed for process control.
9. Glass gems (or molten glass sample if a monolith is being cast)/Feed chute to glass product storage (S10)			
Chemical composition See Footnote c		RCRA/CERCLA Process Control	TCLP: Meet RCRA leachability limits. PCT: For comparative characteristics.
Chemical composition See Footnotes b & c		RCRA/CERCLA Process Control	TCLP: Meet RCRA leachability limits. PCT: For comparative characteristics.
Chemical composition See Footnotes b & c		RCRA/CERCLA Process Control	TCLP: Meet RCRA leachability limits. PCT: For comparative characteristics.
Crystal Structure		Process Control	No crystalline structure observed.
Density		Process Design	2.7 - 2.9 g/cc. Needed for storage and transportation.
Redox state		Process Design	For information only. Needed for full-sized facility design.
Viscosity		Process Control	For information only. Needed for process control.
Electrical Conductivity		Process Control	For information only. Needed for process control.
Radon Emanation		40 CFR 61 Subpart Q (NESHAPS for Radon)	20 $pCi/m^2/s$. Radon emanation should be proportional to the amount of radium in the sample.
Radiation Dose		Process Design	As produced: Required for ALARA and container design. In equilibrium: As stored, 30 days elapsed time. Required for ALARA and for container design.
Glass output/mass balance		Process Design	Need for production rates.
Volume		Process Design	50-68% reduction in volume.
10. Off-gas/Before quench tower (S11)			
Particulate composition See Footnote b & c		Process Design	For information only. Needed for full-sized facility design.

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Table 6-2 CRU4 Pilot Plant Sampling Goals

		DRIVER	GOAL/COMMENTS
Parameter			
Gas composition - Carbon Monoxide - Carbon Dioxide - Sulfur Dioxides - Nitrogen Oxides - Hydrogen Chloride - Total Fluorides - Beryllium - Total Organic Carbon - Organics - Radon-222		Process Design	For information only. Needed for full-sized facility design.
Off-gas flow rate		Process Design	For information only. Needed for full-sized facility design.
Temperature and pressure differentials across all system components		Process Design	For information only. Needed for full-sized facility design.
11. Treated Off-gas/Before discharge to atmosphere (S12)			
Particulate composition See Footnotes b and c		ORC 3704.01-.05 40 CFR 61 Subpart H DOE 5400.5 CH 3 (DCGS in air)	Meet requirements.
Gas composition - Carbon Monoxide - Carbon Dioxide - Sulfur Dioxides - Nitrogen Oxides - Hydrogen Chloride - Total Fluorides - Beryllium - Total Organic Carbon - Organics - Radon-222		OAC 3745-31-05(A)3 Best Available Technology 5400.5 CH 3	
Off-gas flow rate		Engineering Efficiency	Measured to perform calculations to show compliance.
Temperature and pressure differentials across all system components			Required to show compliance.
12. Recycle water/Recycle water line to Quench Tower (S14)			
Percentage of Suspended Solids		Process Design	<1%. For information only. Needed for full-sized facility design.
Percentage of Dissolved Solids		Process Design	<5%. For information only. Needed for full-sized facility design.

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Table 6-2 CRU4 Pilot Plant Sampling Goals

Parameter		DRIVER	GOAL/COMMENTS
13. Cooling Tower Water/Cooling Tower Water Line (S15)			
Percentage of Dissolved Solids		Process Control	<1/2%. For information only. Needed for process control.
Water Chemistry		Process Control	pH8. For information only. Needed for process control.
14. Thickener Overflow (S16)			
Percentage of Suspended Solids		Process Design	<1%. Needed for full-sized facility design.
Percentage of Dissolved Solids		Process Design	<5%. Needed for full-sized facility design.
15. Building Sump Effluent (S17)			
Radionuclides Table b		NPDES Permit OAC 3745-1-07	Must meet site wastewater treatment acceptance criteria.
Heavy Metals Table c		NPDES Permit OAC 3745-1-07	Must meet site wastewater treatment acceptance criteria.
Total Suspended Solids		Process Design	Must meet site wastewater treatment acceptance criteria.

[a] Analytes include Al, B, Ba, Ca, Fe, K, Li, Mg, Na, Si
[b] Analytes include ^{227}Ac, ^{210}Bi, ^{231}Pa, ^{210}Pb, ^{210}Po, ^{223}Ra, ^{226}Ra, ^{99}Tc, ^{227}Th, ^{228}Th, ^{230}Th, ^{232}Th, ^{234}Th, ^{234}U, ^{235}U ^{238}U
[c] Analytes include Ag, As, Ba, Cd, Cr (Hexavalent), Hg, Pb, Se; may also include Al, B, Ca, Fe, Mg, Mn, Na, Si, U

(1) Analytical Methodologies labeled SCQ are found in the *Sitewide CERCLA Quality Assurance Project Plan* (DOE 1992b).
(2) Quality Control requirements such as instrument calibration and method blanks are specified as part of the analytical methodology.

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6.2 TREATABILITY STUDY SAMPLING

The following subsections present the treatability study sampling and test requirements for vitrification, waste water treatment, and off-gas systems.

6.2.1 Vitrification

Figure 4-2 highlights the sampling points for the Pilot Plant process. Materials are pumped from the K-65 Silos to the thickener and sampled (Point S2 on Figure 4-2) for percent solids to measure the slurry pump performance. Underflow from the thickener (S3) will be sampled for percent solids testing to measure the thickener performance. Silo 3 material has been characterized and does not require sampling. The materials are pumped from the thickener into the slurry tanks (S4A or S4B) and sampled for Total Organic Carbon (TOC), anions, radionuclides, wet density, total solids and moisture content, particle size distribution, and weight. Furnace feed materials are sampled (S5) for percent solids determination prior to entry into the furnace. The first furnace feed batch will be analyzed for TCLP as a baseline to judge the effectiveness of vitrification in reducing TCLP results.

Enough glass product will be collected from the gem forming machine (S10) to perform the following analytical, visual and mechanical tests: compression, crush strength, visual appearance of fracture planes, and analysis of the leachate from TCLP and Product Consistency Test (PCT) extraction. TCLP and PCT methods will be used to determine leaching resistance, long term durability, and for comparison of the glass results with performance data from previous high level waste studies. Destructive compression crush tests on some gems will be performed to determine the ability of the glass to deal with external stresses. A minimum crush strength of 100 psi has been chosen (i.e., the force exerted on waste buried under about 120 feet of soil). Additional process control tests include: Density testing to provide data for storage and transportation of the glass, viscosity testing to assure process control of glass flowability, power input control tests for control of melt temperatures, glass output/mass balance for production rates, and system performance and mass balance. Also, testing will be performed to determine the reduction in radon emanation from the final product, radiation from the final product, and the overall volume reduction achieved by the process.

6.2.2 Process Off-gas Systems

Process off-gas will be sampled and tested at two locations in the process. The process off-gas will be sampled before the quench tower (S11) and before discharge to the atmosphere (S12) for particulate composition of selected analytes, gas composition (including radon), and off-gas flow rates. Temperature and pressure differentials will be measured throughout the off-gas system. An isokinetic sampler will be used to determine the type and amount of particles in the off-gas stream before release to the atmosphere. The system will have alarms at the operations control panel to alert operations personnel of the need to take appropriate specified actions, as necessary.

6.2.3 Waste Water Treatment

Waste water sampling at the filter effluent point (S1) includes analysis for radionuclides, heavy metals, and suspended solids. Recycled water (S14) will be sampled and analyzed for percentage of suspended solids and percentage of dissolved solids for determination of the effectiveness of the thickener and buildup of salts in the recycle loop. Cooling water will be tested (S15) and analyzed for percentage of dissolved solids for soluble salt buildup and water chemistry prior to waste water treatment.

6.3 SAMPLING METHODOLOGY

Sample collection procedures, sample size, sample containers, and preservatives will be determined according to Table 6.1 and Appendix K (sampling method) of the SCQ (DOE 1992b). Sample tracking and control documentation will be conducted in accordance with Section 7.1 of the SCQ and sample packaging and shipping will be conducted as specified in Section 6.7 of the SCQ. All packaging and shipping of hazardous materials (both on-site and off-site) will comply with DOE Order 5480.3 (Safety Requirements for Packaging and Transportation of Hazardous Materials) and FEMP Procedure PP-0314 (Procedures for Packaging and Transportation of Hazardous Materials).

6.4 ANALYTICAL METHODS

To the extent possible, analytical methods from the SCQ will be utilized. Additional process and analytical procedures may be presented or developed by laboratories used to perform analyses to support this effort. These procedures will be reviewed and approved as required by the SCQ prior to performance of any analyses. The level of confidence in the analytical methods used for this pilot scale test will be comparable to confidence levels in SCQ methods.

6.5 DATA QUALITY OBJECTIVES AND ANALYTICAL SUPPORT LEVELS

Based on the requirements of Section 3.0 and Section 4.0, Data Quality Objectives have been developed for sampling, analysis, and data management for data collection and sampling performed under this Work

Plan. End use data will be presented according to the SCQ qualitative and quantitative statements for data quality. The FEMP analytical support levels defined in the SCQ (analogous to the 1987 EPA-defined levels) are shown in Table 6-1 as the FEMP assigned ASLs. Data characterized at Analytical Support Level "A" do not require validation. Analytical Support Level "B" will not require validation of data collected because testing is mechanical, but it will require the recording of the results of duplicate or triplicate samples collected for these tests. Analytical Support Levels of "C" and "D" will require sampling, analyses, and data management to support the validation of data required by the SCQ.

6.6 QUALITY ASSURANCE REQUIREMENTS

Quality Assurance for the Phase II program will be in accordance with quality program elements identified in FERMCO RM-0012, Quality Assurance Program Description, for the management of the program. The SCQ will be used for quality program elements for sampling, analysis, and data reporting activities covered by this Work Plan.

Specific CRU4 quality elements applicable for the management of the project include Personnel Training and Qualifications, Quality Improvement, Documents and Records, Work Performance, Inspection, and Acceptance Testing. Sections 6.8, 6.10 and 6.11 provide specific QA requirements necessary to be performed for this work.

6.7 DATA REDUCTION, VERIFICATION AND QUANTIFICATION

Data reduction, verification, and quantification will be conducted according to Section 8.0 of this Work Plan and Section 11.0 and Appendix D of the SCQ.

6.8 PERFORMANCE AND SYSTEM AUDITS

Performance and system audits of the activities covered by this Work Plan will be performed in accordance with Section 12.0 of the SCQ and FERMCO RM-0012. Self-assessments in the form of surveillances will be performed and scheduled by CRU4. Independent audits will be performed and scheduled by FERMCO QA. Other independent audits may be performed by DOE or USEPA as required.

6.9 CALCULATIONS OF DATA QUALITY INDICATORS

Equations used to calculate data quality indicators and results determining instrument linearity, ongoing instrument calibration compliance, precision, and accuracy will be performed in accordance with requirements of Section 14.0 of the SCQ.

6.10 CORRECTIVE ACTION

Corrective action will be performed in accordance with requirements of Section 15.0 of the SCQ and FERMCO Quality Assurance Programs and Procedures.

6.11 QUALITY ASSURANCE REPORTS TO MANAGEMENT

Section 16.0 of the SCQ will be used to direct activities for requirements of quality reports to management.

For TCLP testing, quality assurance shall be guided by 40 CFR Part 261, Appendix II.

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7.0 DATA MANAGEMENT

Data and records generated by the Phase II Pilot Plant Project used to support the OU4 Feasibility Study alternatives for treatment via vitrification will be managed in accordance with Section 4.4 and Appendix F (applicable sections) of the FEMP Records and Document Control Administration procedures (as applicable) and the SCQ, respectively. Field and laboratory data collected as part of Phase II will be maintained and recorded in accordance with applicable SCQ requirements. Phase II process operational tests and engineering design data will be managed in accordance with FEMP and CRU4 Records Management requirements where the SCQ is not applicable.

Where they are identified, field and laboratory records will be maintained in log books or on SCQ forms that are reviewed, signed and dated by the responsible persons. These reviews include Quality Control reviews of field generated records, laboratory reviews of analysis records generated, and data validation records generated on data required to be validated by this project plan. Where necessary, CRU4 will generate records using forms which will identify Phase II operation testing requirements, equipment calibration and preventative maintenance, verification of numerical results, checks for data entries, transcriptions and calculations, and records of training performed.

Computer programs for modeling in support of Phase II will be verified and validated. Data will be backed up on disks and printouts of processed data will be filed in appropriately labeled binders or notebooks as required by the SCQ.

Based on the requirements of Sections 12 and 14 of the SCQ, quality records generated for this project will be identified, and information on corrective actions taken will be provided in final reports, if applicable. These records will be managed in accordance with SCQ and CRU4 Document Control program requirements.

8.0 DATA ANALYSIS AND INTERPRETATION

Sampling and analysis data generated to provide characterization for Resource Conservation and Recovery Act (RCRA) and radiological programs will be validated according to FEMP Data Validation Program requirements for ASLs identified in Table 6-1 (Section 6.0). ASL B data resulting from the activities defined by this work plan will not require validation. Field sampling documents will be reviewed by the FEMP Quality Control organization to verify completeness and intercomparability of information.

Sampling and analysis data from start-up and operation will be analyzed based on performance and data quality objectives identified in Section 6.0. Operational sampling identified as ASL C and D will be validated using FEMP Data Validation program requirements. Data generated by the activities defined in this work plan under ASLs A and B will not require validation because it is limited to the support of Phase II design and operation and is not tied to regulatory concerns.

Data generated from this project will be used to support the Feasibility Study for Operable Unit 4 alternatives for treatment via vitrification. Results will be incorporated into the remedial design documents if vitrification is presented and approved as the remedial alternative in the ROD.

9.0 HEALTH AND SAFETY

All activities conducted within the confines of Operable Unit 4 are governed by the requirements of the "FERMCO Comprehensive Environmental Occupational Safety and Health Program Manual" (ESH-1-1000), and the "CERCLA/RCRA Unit #4 General H&S Plan for OU4 Operations," (18-HS-0001). In addition to these general requirements, a Project Specific Health and Safety Plan (PSHSP) is prepared for each project or major new activity. A PSHSP will be prepared for both Phase I and Phase II activities of the Pilot Plant program.

The Comprehensive Safety and Health Program addresses environmental, occupational, industrial, and construction health and safety. Also included in this Comprehensive Program are the Industrial Hygiene Program, the Fire Protection Program, the Emergency Preparedness Program, the Emergency Response Program, Medical Services, and the Radiological Protection Program.

The General Health and Safety Plan (HASP) identifies the hazards within the Operable Unit 4 area, and establishes the guidelines and requirements for safety of personnel during the conduct of the field activities within the confines of Operable Unit 4. All FERMCO employees, visitors, vendors, contractors, and subcontractors are required to abide by the provisions of the approved "CERCLA/RCRA Unit 4 (CRU4) General HASP." As previously stated, while the general plan identifies and reviews the hazards common to Operable Unit 4 field activities, it does not address hazards associated with specific tasks/operations.

The Operable Unit 4 HASP was prepared in accordance with the requirements of the Occupational Safety and Health Administration (OSHA) Regulations 29 CFR Part 1910.120 (Hazardous Waste Operations and Emergency Response, Final Rule - 6 March 1989).

Management and supervision have the responsibility for assuring that the requirements of the applicable H&S plans are met. Occupational Safety and Health (OSH) field personnel (Technicians, Specialists and Engineers) have the authority to enforce the requirements of the applicable H&S plans. All personnel have stop-work authority for imminent safety hazards and noncompliance with the applicable H&S plans.

10.0 RESIDUALS MANAGEMENT

This section describes the management of residual materials resulting from Pilot Plant Phase II operations.

10.1 VITRIFIED RESIDUES

The Pilot Plant will have a campaign of about 30 operating days, with an assumed processing rate of one mtpd, based on 24-hour continuous operation. The actual time frame of Pilot Plant operations will cover several months. The vitrification process will preferably form the glass in the shape of small spheroids, flattened on one side, of one to two cm in diameter. Alternately, monolithic castings may be produced. At a processing rate of one MTPD, approximately 30 metric tons (66,000 lb) of vitrified material will be produced.

The vitrified waste will be packaged in 55 gallon drums placed inside individual shielded casks for storage at the Pilot Plant and transported to on-site interim storage. Additional shielding will be used as required to protect personnel at the drum filling and staging area. About three drums will be required for each metric ton of material. The drums will be immediately moved from the proposed vitrification facility area to an approved on-site storage facility for interim storage pending final disposition consistent with the Record of Decision for Remedial Actions at Operable Unit 4. The drums will be placed on standard size pallets, stacked three pallets high, and will occupy an area of approximately 28 m^2 (300 ft^2). Material management will be in accordance with all pertinent ARARs, DOE orders, and Site Standard Operating Procedures (SSOPs).

10.2 WASTE WATER TREATMENT RESIDUES

The waste water pre-treatment system will be a mixed-media filter with a backwash system. Samples will be collected from the system discharge line, possibly at the filter, and characterized prior to release. This liquid fraction of the waste water, if approved through characterization, will be sent through the FEMP Advanced Waste Water Treatment System under the existing National Pollutant Discharge Elimination System (NPDES) permit. Solids from backflushing the filter will be returned to the thickener for processing. All materials will be managed in compliance with all pertinent ARARs and SSOPs.

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10.3 RESIDUES FROM AIR POLLUTION CONTROL

The design parameters of the air pollution control system, potential release points, and types of pollutants which could potentially be released are discussed in this section.

- Radon emissions: The proposed vitrification process design requires two parallel activated carbon bed sets, each with a nominal 250 SCFM air flow rate. With a 97 percent collection efficiency, the expected release rate of radon from this system is 1100 pCi/liter in 250 SCFM while the furnace is being fed. This will result in about 0.3 Ci of radon being released over a 30 day campaign. This estimated quantity of radon does not exceed the concentration guide lines established in DOE Order 5400.5 for exposure of members of the public to radon. The system will be designed to limit the concentration of radon in any worker occupied area to 30 pCi/L.

  The Sampling and Analysis Plan addresses confirmation that the gas composition meets regulatory requirements.

  To limit radon release from the silos during removal of material, the proposed silo waste retrieval design requires bag-in/bag-out deployment of the slurry pump to maintain the silo in a sealed state. The existing RTS will be refurbished and will be used as it has in the past to reduce the radon concentration in the silo head space so that dose rates for workers at the silo are acceptable.

- Air Particulates: HEPA filters with a design efficiency of 99.97 percent will be used for particulate emissions.

- SOx emissions: These will be scrubbed by caustic solution in a 99 percent efficient counterflow scrubber and will be in compliance with OAC 3745-31-05(A)(3), which requires the use of Best Available Technology (BAT).

- Nitrogen Oxide (NOx) emissions: Emissions are estimated to be approximately 2.0 lb per hour, or 50 ppm in 6250 SCFM. This would be 8.8 ton per year if the Pilot Plant were operated continuously. Prevention of Significant Deterioration (PSD) requirements become effective at 40 tons per year, so PSD requirements do not apply. As required by OAC 3745-23-06(B), "..., all stationary nitrogen oxide emission sources shall minimize nitrogen oxide emission by use of the latest available control techniques and operating practices in accordance with best current technology." Because of the short (30 day) operating run for the Pilot Plant, a NOx destruction unit is not required.

- Cooling tower: This will release uncontaminated water vapor and mist containing non-hazardous dissolved solids, i.e., this is a standard cooling tower operation.

- Plant stack size, diameter, and monitoring: The stack size will be based on a 7000 SCFM maximum flow rate, with 250 SCFM as is the nominal flow rate expected from the Pilot Plant process off-gas, 6000 SCFM from the furnace room ventilation system, and 400 SCFM intermittent flow from the additives/Silo 3 solids transfer blower. Real-time stack monitoring equipment will be available for both radionuclides and metals. Refer to Table 6-1 for pollutants to be sampled for material balance purposes.

Compliance with all pertinent ARARs will be performed for the management of residual materials produced from the off-gas control systems.

10.4 WASTES FROM CHARACTERIZATION AND OPERATIONS

All wastes will be properly characterized and managed in accordance with existing site procedures. Characterization of all waste generated during construction projects, including soils, is currently performed using SSOP-0044. The project engineer initiates this process by completing the Construction Waste Identification/Disposition (CWID) form which identifies types and amounts of waste that will be generated during the project. All other wastes generated are currently characterized according to SSOP-0002. This process is initiated by the generator completing the Material Evaluation Form (MEF). A MEF is completed for each waste stream and provides essential information which is used to complete the characterization. All waste characterizations are currently performed by the Waste Characterization Group. If any SSOPs, forms, group names, or responsibilities referenced above are changed, then waste generated through this project will be characterized according to those changes. All samples and other wastes from testing or characterization efforts will be dispositioned in accordance with ARARs identified for the project, and with approved site procedures.

In addition to the vitrified materials produced, the following waste streams will be produced during this operation:

- Personnel protective equipment (PPE) from an estimated 30 person crew.
- Carbon from radon control equipment
- HEPA Filters
- Process building lab waste
- Operations, maintenance, and office cleaning waste, etc.
- Waste from decontamination of equipment
- Glove bags and expendable fittings

10.5 WASTE MINIMIZATION

As a National Priorities List (NPL) site, the FEMP is making efforts to reduce the generation of waste requiring special handling. By eliminating unnecessary waste generation, the FEMP reduces the cost, risk, and burden on available waste management facilities during management of the waste. Several aspects of Pilot Plant construction and operation were designed to facilitate waste minimization.

There will be provisions for the segregation of waste streams. All waste disposition will be dictated by characterization of each waste stream. Dumpsters will be used to collect non-contaminated (i.e., non-radioactive) and non-hazardous scrap for disposal at a commercial sanitary landfill. This will avoid the disposal cost of shipping the material to NTS as LLRW and will provide a means to segregate the material to avoid contamination as it is being accumulated.

The hydraulic mining process uses water to slurry the material to facilitate removal. The water will be collected and recycled through the process in a closed-loop system which substantially reduces the generation of waste water requiring treatment before release. This will also reduce the cost of transferring the water to the FEMP site treatment system and the management of the additional sludge that would be generated there.

The waste water filter sludge will be recycled via backwash to the thickener for incorporation of the solids into the vitrified product.

Additional waste minimization efforts may be identified as the project progresses and will be evaluated at that time. The minimization efforts referenced above may also be modified as the project progresses or as the need arises.

11.0 COMMUNITY RELATIONS

Treatability studies and community information and involvement activities are required in the CERCLA process. Community relations activities will be conducted to explain the role of treatability studies in the OU4 RI/FS. This will confirm confidence in the cleanup alternatives, technologies identified in the alternatives screening/analysis process, and in the preferred alternative for OU4.

In accordance with CERCLA and the National Oil and Hazardous Substances Pollution Contingency Plan (NCP), information regarding this document and the vitrification technology will be provided to individuals via Fernald site publications; briefings at community, township, and Fernald Residents for Environmental Safety and Health (FRESH) meetings; and the public participation activities.

In addition to attending community meetings and participating in Fernald-related activities, individuals can also obtain information by examining the Administrative Record, which contains documents relevant to the RI/FS for the site, including Operable Unit 4. The Administrative Record is located in the Public Environmental Information Center, 10845 Hamilton-Cleves Highway, just south of the Fernald site.

Public Environmental Information Center Hours

Phone: 513-738-0164

Monday and Thursday, 9 a.m. to 8 p.m.

Tuesday, Wednesday and Friday, 9 a.m. to 4:30 p.m.

Saturday, 9 a.m. to 1 p.m.

Although the law does not require a formal public comment period on treatability study work plans, individuals will have opportunities to provide input regarding the Vitrification Pilot Plant and other OU4 projects through public participation activities that will be conducted to promote communications between the FEMP and the community.

For more information about this document or the Fernald site, individuals may contact:

Mr. Ken Morgan	Mr. Jim Saric
Public Information Director	Remedial Project Director
DOE Field Office, Fernald	U.S. EPA 5HRE 8J
P.O. Box 398705	77 West Jackson Boulevard
Cincinnati, OH 45239-8705	Chicago, IL 60604
Phone: 513-648-3131	Phone: 312-886-0092

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12.0 REPORTS

12.1 MONTHLY REPORTS

The progress made in meeting the Pilot Plant Phase II Program milestones and identification of any technical issues that may develop during the course of work will be reported to the USEPA via the "Consolidated Consent Agreement/Federal Facility Compliance Agreement/Federal Facility Agreement to Control and Abatement of Radon-222 Emissions Monthly Progress Report."

12.2 BI-WEEKLY STATUS MEETINGS

A regularly-scheduled bi-weekly status meeting is held with the DOE-FN to summarize the progress made in the Pilot Plant Phase I construction, start-up and operation and to discuss any relevant issues that may develop during the course of work. Regularly-scheduled status meetings will continue to be held through Phase II on a schedule that is commensurate with the needs of the program.

12.3 FINAL REPORT

A final report will be generated following the completion of Phase II of the project. The report will include a description of all of the work performed in Phases I and II, along with summary data from both laboratory and site operations performed in the project, technical discussion, results, and conclusions. Preparation of this report is the responsibility of the Project Director and submittal to DOE-FN will be scheduled to occur within ninety (90) days after completion of the Phase II project. A suggested format for the final report is presented in Table 12-1. This format is based on USEPA guidance for Treatability Study Reports that are conducted as CERCLA activities.

TABLE 12-1

Suggested Organization of the Treatability Study Final Report

1.0 Introduction
- 1.1 Site description
  - 1.1.1 Site name and location
  - 1.1.2 History of operations
  - 1.1.3 Prior removal and remediation activities
- 1.2 Waste stream description
  - 1.2.1 Waste matrices
  - 1.2.2 Pollutants/chemicals
- 1.3 Treatment technology description
  - 1.3.1 Treatment process and scale
  - 1.3.2 Operating features
- 1.4 Previous treatability studies at the site

2.0 Conclusions and Recommendations
- 2.1 Conclusions
- 2.2 Recommendations

3.0 Treatability Study Approach
- 3.1 Test objectives and rationale
- 3.2 Experimental design and procedures
- 3.3 Equipment and materials
- 3.4 Sampling and analysis
  - 3.4.1 Waste stream
  - 3.4.2 Treatment process
- 3.5 Data management
- 3.6 Deviations from the Work Plan

TABLE 12-1

(continued)

4.0 Results and Discussion

- 4.1 Data analysis and interpretation
  - 4.1.1 Analysis of waste stream characteristics
  - 4.1.2 Analysis of treatability study data
  - 4.1.3 Comparison to test objectives
- 4.2 Quality assurance/quality control
- 4.3 Costs/schedule for performing the treatability study
- 4.4 Key contacts

References

Appendices

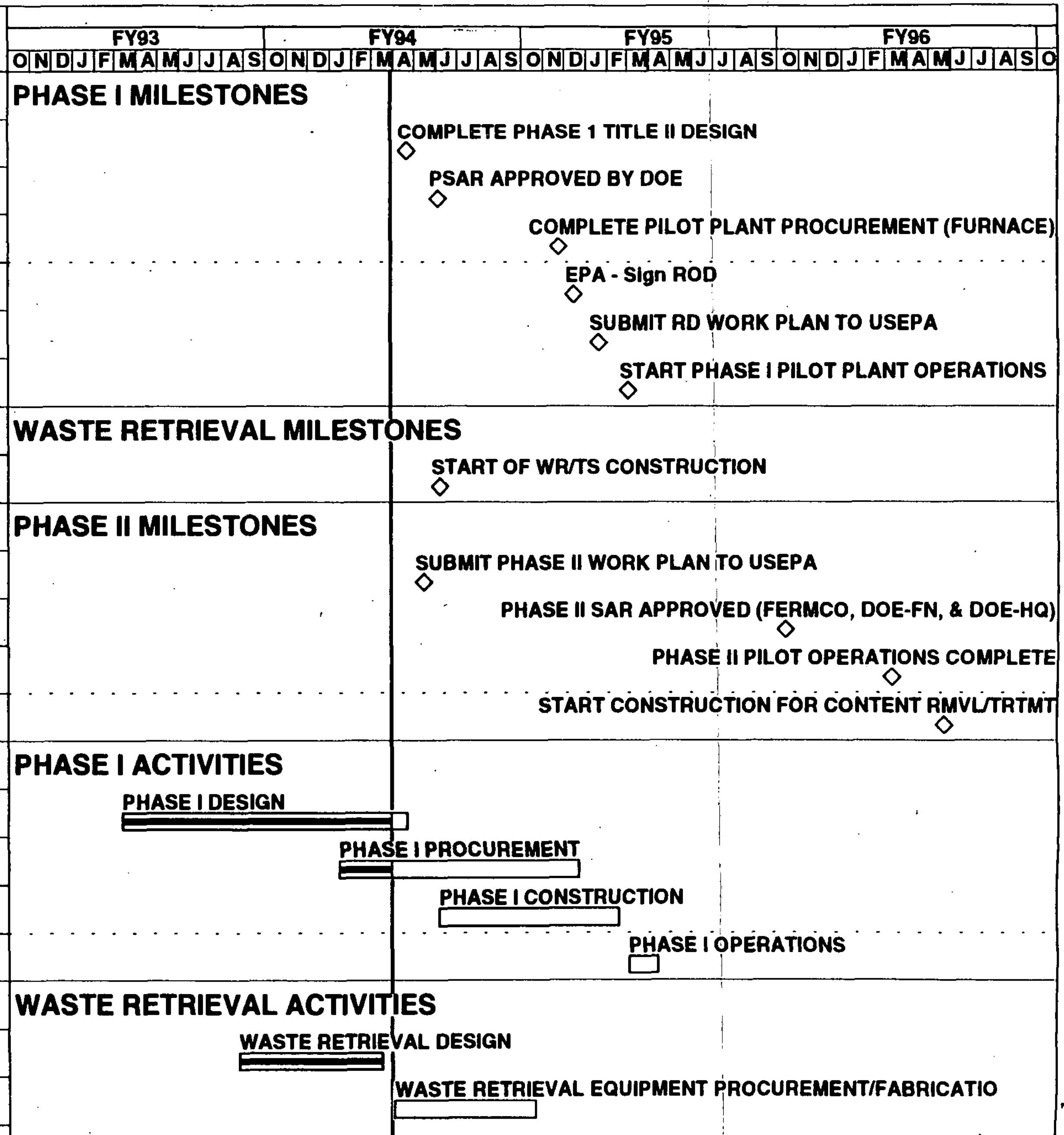
- A. Data summaries
- B. Standard operating procedures

13.0 SCHEDULE

Figure 13-1 includes activities required to complete the Phase II Pilot Plant Treatability Study (for vitrification of K-65 and Silo 3 material) and the Remedial Action programs for the Silos and the OU4 area. The schedule of activities is driven by the milestones that are incorporated in the Amended Consent Agreement and the resource-loaded schedules included in the DOE-approved five-year plan. Any and all changes to this baseline schedule require approvals that are obtained via a formal change control procedure.

FIGURE 13-1

ACTIVITY ID	EARLY START	EARLY FINISH	REM DUR
4VP1M024		19APR94	0
4VP1M018		3JUN94	0
4VP1M028		22NOV94	0
4RIFM214		14DEC94	0
4CP3MM01		18JAN95	0
4VP1M038	2MAR95		0
4XRSM012	6JUN94		0
4JP2M006		13MAY94	0
4JP2M012		10OCT95	0
4JP2M044		8MAR96	0
4CP3MM53	21MAY96		0
4VP1H010	11MAR93A	19APR94	16
4VP1H014	12JAN94A	19DEC94	184
4VP1H016	3JUN94	15FEB95	175
4VP1H018	2MAR95	12APR95	30
4XRSH010	23AUG93A	14MAR94A	0
4XRSH016	31MAR94	18OCT94	140



Plot Date 10MAY94 Data Date 28MAR94 Project Start 1OCT85 Project Finish 30SEP02 (c) Primavera Systems, Inc.	Activity Bar/Early Dates Critical Activity Progress Bar Milestone/Flag Activity	Sheet 1 of 2 FEMP CURRENT SCHEDULE CERCLA/RCRA UNIT 4 MASTER SCHEDULE	REV 942 WGF/WSP Date / Revision / Checked / Approved

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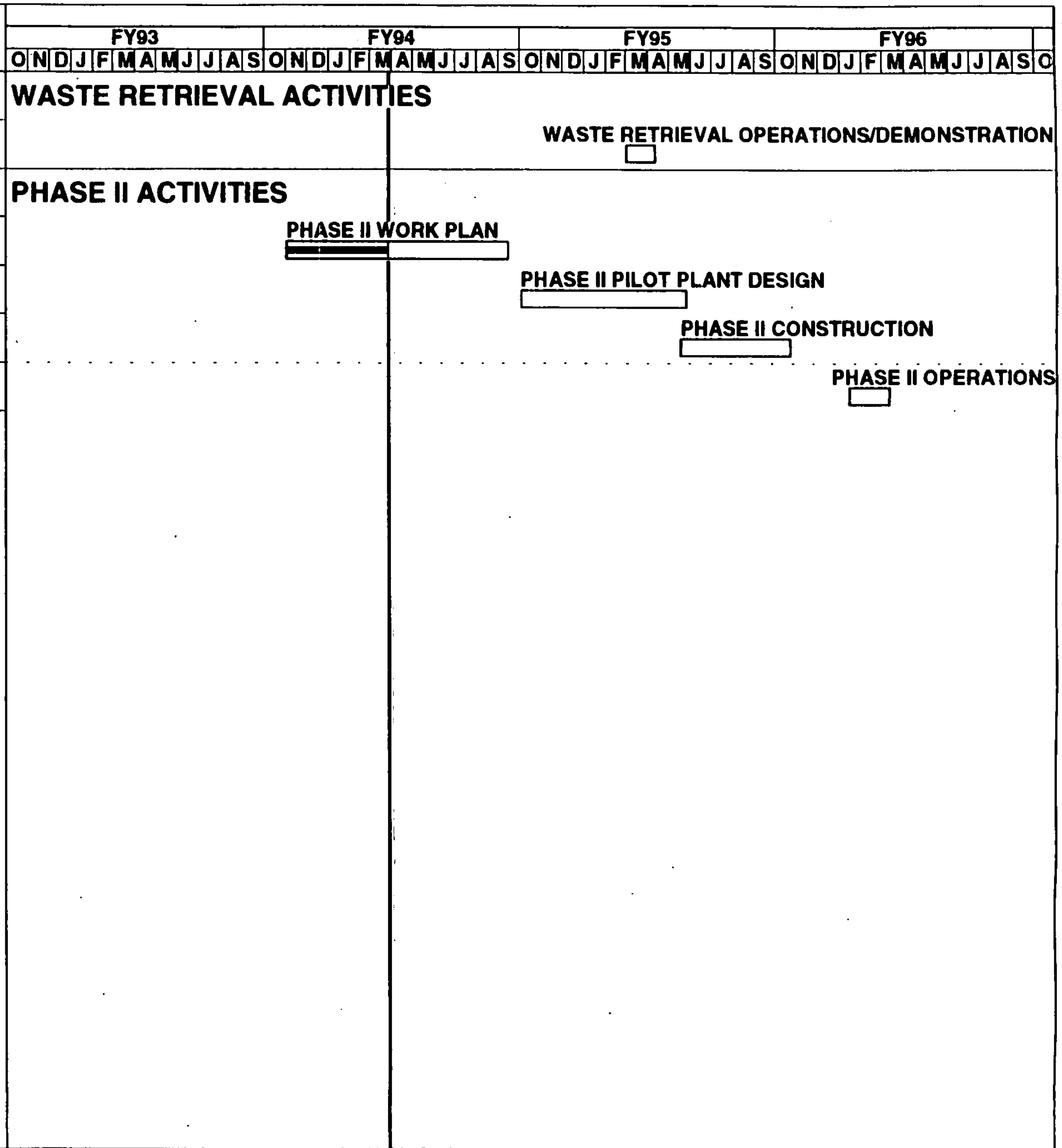
FIGURE 13-1 (cont.)

ACTIVITY ID	EARLY START	EARLY FINISH	REM DUR
WASTE RETRIEVAL ACTIVITIES			
4XRSH020	2MAR95	12APR95	30
PHASE II ACTIVITIES			
4JP2H002	2NOV93A	15SEP94	120
4JP2H008	3OCT94	25MAY95	161
4JP2H018	17MAY95	20OCT95	110
4JP2H022	12JAN96	8MAR96	40



Plot Date 10MAY94
Data Date 28MAR94
Project Start 1OCT85
Project Finish 30SEP02

(c) Primavera Systems, Inc.

Activity Bar/Early Dates
Critical Activity
Progress Bar
Milestone/Flag Activity

Sheet 2 of 2

FEMP CURRENT SCHEDULE
CERCLA/RCRA UNIT 4
MASTER SCHEDULE

REV 942 WGF/WSP

Date	Revision	Checked	Approved

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14.0 MANAGEMENT AND STAFFING

The Pilot Plant Program supports the remediation of Operable Unit 4 at the Fernald Environmental Management Project. The governing document is the Amended Consent Agreement between the U.S. DOE and the USEPA Region V, signed in September 1991. As such, ultimate project management responsibility lies with these two agencies as defined by this agreement. In addition, the OEPA has been granted regulatory authority over certain RCRA activities. Each agency has engaged contractors to perform identified scopes of work related to their prime areas of responsibility for site remediation. Figure 14-1 shows this responsibility matrix, and Figure 14-2 identifies the lead personnel.

Within each agency, various organizations and offices have been delegated specific program responsibilities. Direct management of this Pilot Plant Phase II program is delineated as described in Section 14.1.

14.1 PROJECT MANAGEMENT

The Pilot Plant program is being developed for, and will be implemented as, the third tier RD/RA (Remedial Design/Remedial Action) Treatability Study of the U.S. EPA-outlined approach to conducting treatability studies at a Superfund site (1992). Thus, the 1991 Amended Consent Agreement is the overall governing document, with the project being conducted in compliance with EPA guidance for CERCLA activities and site operations being conducted in compliance with DOE Orders. (Note that DOE Orders are currently included as TBCs in the list of ARARs and TBCs for remediation under CERCLA).

The Phase II program will be conducted in compliance with this Work Plan document as approved by the Remedial Project Director, USEPA Region V. The DOE Office of Environmental Restoration will oversee the program via its Fernald Field Office (DOE-FN). The DOE has retained the Fernald Environmental Restoration Management Corporation (FERMCO) as the Environmental Restoration Management Contractor (ERMC) for site remediation. Remediation projects for Operable Unit 4 are managed by CERCLA/RCRA Unit 4 (CRU4), so named in recognition of the principal legislation governing remedial activities.

FERMCO will implement the program for the DOE-FN via its own workforce and subcontractors. The Architectural/Engineering firm, Parsons, is under contract to FERMCO to perform engineering design services for remediation. When required, other subcontractors and FERMCO home office support from teaming partners is utilized to accomplish specialized tasks or unique scopes of work. Within FERMCO, the CRU4 Director has lead responsibility for implementing the overall Pilot Plant Phase II program.

FEMP OU4 Remediation

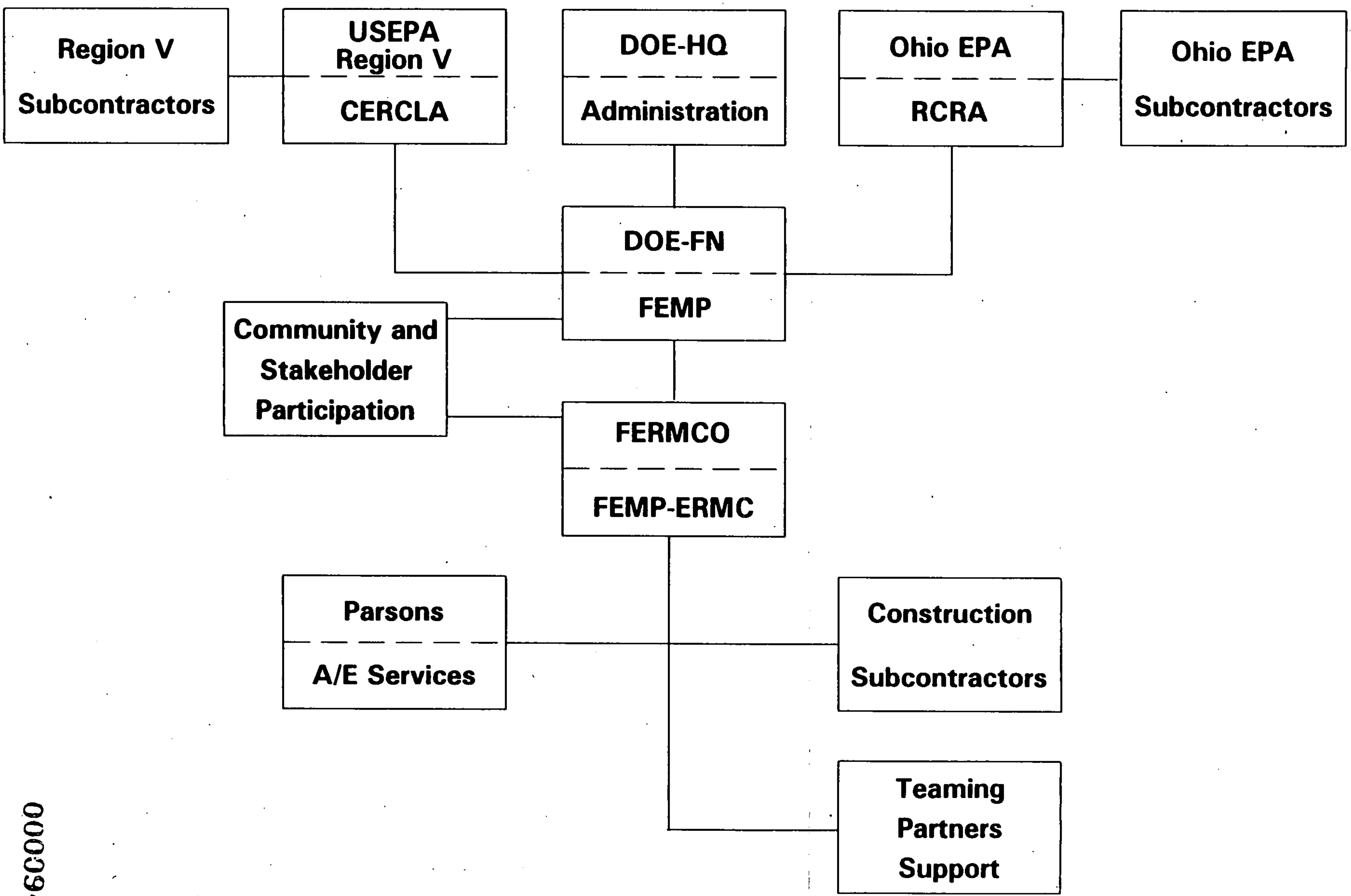

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Figure 14.1 Administrative Relationship

CERCLA/RCRA Remediation

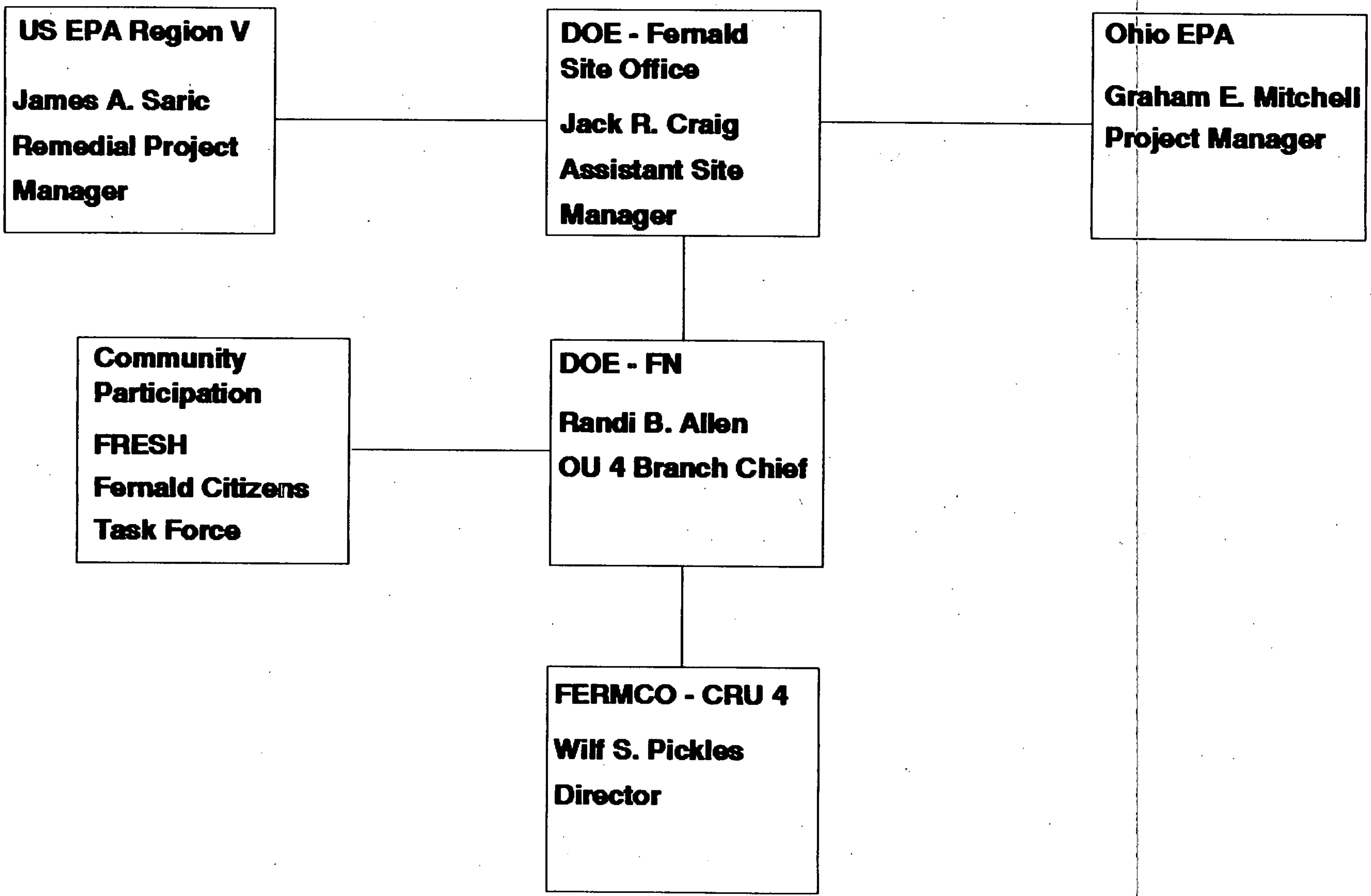


Figure 14.2 Operable Unit 4 Remediation

14.2 STAFFING

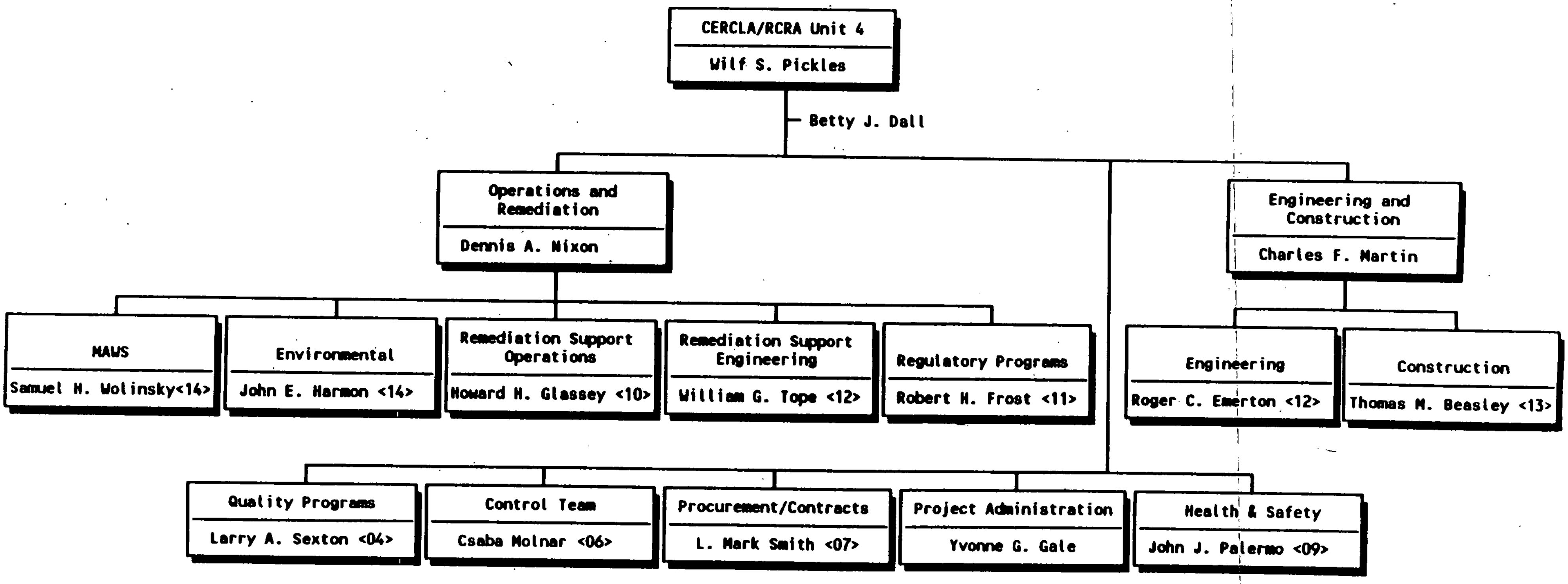
The FERMCO organization consists of project divisions (such as CRU4), support divisions (such as Engineering), and service departments (such as Analytical Services). The support divisions supply full-time personnel to the project on a matrix basis. This may range from a single point of contact (such as a procurement representative) to a full department (such as Environmental, Engineering, or Construction). Service organizations (such as Analytical Services) provide support on a request-for-services basis from a document that is generated for each specific work request. Figure 14-3 is an organization chart that depicts the CRU4 responsibilities for the Pilot Plant program activities.

Within the CRU4 organization, operations are conducted in accordance with "CRU4 Operating Procedures," 18-PR-001 which became effective on February 28, 1994. These CRU4 division procedures address the 12 major areas of operations for which the CRU Director is responsible. These procedures define responsibilities, interactions within the CRU4 organization, and relationships with the home divisions for matrixed personnel.

Briefly, the function responsibilities within the CRU4 organization are as follows. The CRU4 Director is the Program Manager. The Assistant CRU4 Director, Engineering and Construction serves as the Pilot Plant Project Manager during the design and construction phase. The Assistant CRU4 Director, Operations and Remediation is responsible for all RI/FS program and environmental compliance activities. The Engineering Department Manager is responsible for facility and process design, as well as Project Engineering support activities. The Construction Manager is responsible for facility construction. The Engineering, Construction, and Operations and Remediation Departments maintain responsibility through the check-out and start-up phases. As a treatability test program, the actual testing will be directed by professional staff; the CRU4 Remedial Site Operations Manager is responsible for supplying building services and equipment operators.

FIGURE 14-3

FERNALD ENVIRONMENTAL RESTORATION
MANAGEMENT CORPORATION
CERCLA/RCRA UNIT 4



15.0 BUDGET

The budget for the Pilot Plant project is contained in the "FEMP Baseline for FY 94 -99," WBS Element 1.1.1.1.4, which is titled "OU4, Silos 1-4." The FEMP Baseline document contains the resource-loaded schedules for the individual components of the integrated program, and that document is the reference for the budget details. Summary level totals for each major component by fiscal year are shown here in Tables 15-1 through 15-3. These tables address the design and construction of the required facilities, but not the operation or eventual demolition and environmental restoration.

TABLE 15-1

Total Estimated Costs for the Integrated Pilot Plant Project

ITEM	FY-94	FY-95	FY-96	TOTAL
FERMCO Labor	1,659,877	905,109	115,080	2,680,066
Subcontractors	5,518,832	6,273,223	0	11,792,055
Materials	4,695,951	3,449	2,988	4,702,388
TOTAL ESTIMATED COST	11,874,660	7,181,781	118,068	19,174,509

TABLE 15-2

Costs for the Pilot Plant Facility

ITEM	FY-94	FY-95	FY-96	TOTAL
FERMCO Labor	146,808	263,528	0	410,336
Subcontractors	1,721,466	5,859,895	0	7,581,361
Materials	4,639,511	0	0	4,639,511
TOTAL ESTIMATED COST	6,507,785	6,123,423	0	12,631,208

TABLE 15-3

Costs for Waste Retrieval and Transfer

ITEM	FY-94	FY-95	FY-96	TOTAL
FERMCO Labor	293,033	104,124	0	397,157
Subcontractors	1,301,673	207,209	0	1,508,882
Materials	0	0	0	0
TOTAL ESTIMATED COST	1,594,706	311,333	0	1,906,039

FERMCO labor includes only the direct labor charges made by FERMCO employees. The "Subcontracts" costs represent the estimated costs of subcontracts for design and construction. The "Materials" costs represent the cost of materials purchased to operate the facility.

16.0 REGULATORY COMPLIANCE

Regulatory requirements governing construction activities and operation of the Phase II Pilot Plant for vitrification and waste retrieval are discussed in this section. The vitrification facility will be designed to produce a consistent stabilized glass with minimal effluent. In Phase II, the systems will be tested using K-65 and Silo 3 (i.e., radioactive) materials.

The project will include running power and process lines to the silos, operation of waste retrieval equipment at Silo 1 or 2 and 3, operation of the pilot plant, and dispositioning of residuals as discussed in Section 10.0.

16.1 REMOVAL SITE EVALUATION (RSE) GUIDANCE

Construction during this project might require excavation of soils, and could generate construction rubble and debris. Pursuant to the NCP under 40 CFR Part 300.410, a Removal Site Evaluation (RSE) must be conducted to assess the potential for an activity to release hazardous substances to the environment. The purpose of this requirement is to determine whether a removal action should be conducted prior to remediation of an unknown, or previously uncharacterized area. The activities proposed by this work plan are to be conducted in an area where there has been previous investigation and data collection under the RI for OU4. Based on analysis of these data, process knowledge of operations conducted in the area, and current knowledge of "hot spots," no removal action would be warranted for activities conducted in this area prior to the remedial activities, including construction and operation of the Pilot Plant.

The activities proposed in this work plan will be conducted in support of the remediation of OU4 under CERCLA Section 104. Since treatability studies are part of the response action planned for OU4, a formal RSE is not required. A letter from the DOE, dated April 16, 1993 (see Appendix B), supports this position. Documentation of existing data and information, along with engineering controls and procedures described in this work plan, will meet the substantive requirements of an RSE as outlined in 40 CFR Part 300.410. The construction activities described in this work plan will comply with the requirements of site procedure SSOP-0044, Management of Soil, Debris, and Waste from a Project. If "hot spots" are encountered during construction, or if at any time during this phase of operation it is determined that a potential exists for release of hazardous substances to the environment, an RSE will be conducted to determine whether a removal action is warranted.

16.2 NATIONAL ENVIRONMENTAL POLICY ACT (NEPA) COMPLIANCE

The National Environmental Policy Act (NEPA) is applicable to all FEMP activities that may impact environmental resources, including biota, wetlands, cultural, historical, anthropological or socio-economic factors. NEPA requires assessment of environmental impacts associated with all proposed DOE projects. The DOE will determine the appropriate documentation required in accordance with regulations implemented under 10 CFR Part 1021, DOE Orders 5440.1D and 5400.4, and Site Procedure SSOP-0031. A request package containing the "Request for NEPA Services" and "Environmental Compliance Questionnaire," along with a project schedule and scope of work, is standard procedure to initiate a NEPA determination for a site project. NEPA documentation for Phase II of the Pilot Plant Project has been prepared as a Categorical Exclusion (CX), and submitted to the DOE for approval in accordance with DOE Order 5440.1D (NEPA compliance program) and the NEPA Document Process Procedure (SSOP-0031).

16.3 RESOURCE CONSERVATION AND RECOVERY ACT (RCRA) COMPLIANCE

The minimal amount of construction envisioned for Phase II is not anticipated to produce any hazardous wastes. However, all wastes will be subject to characterization. If the waste characterization indicates the material contains hazardous waste constituents, the material would be subject to the substantive RCRA requirements for the management, storage, and final disposition as RCRA hazardous waste.

The residues in Silos 1, 2, and 3 are by-product material which is excluded from regulation under RCRA by 40 CFR Part 261.4. The residues resulted from the production of uranium metal from source material such as pitchblende ores. Since the waste materials meet the exclusion, the RCRA regulations are not directly applicable as ARARs. However, the materials stored in the silos contain elevated levels of natural metals such as lead which exhibit a characteristic of RCRA hazardous waste. Due to the hazard associated with the toxicity of the metals, the substantive requirements of RCRA are adopted as relevant and appropriate to ensure protectiveness during this activity.

16.4 PERMITTING ISSUES

CERCLA Section 121(e)(1) states that no Federal, State, or Local permit shall be required for the portion of any removal or remedial action conducted entirely on site, where such remedial action is selected and carried out in compliance with Section 121.

As a treatability study preceding CERCLA remedial actions, this Pilot Plant project is not required to obtain any Federal, State, or Local permits. However, the project must be conducted in accordance with the terms and conditions of those permits that otherwise would have been required. As a consequence, only the substantive portions of those ARARs governing environmental regulatory requirements have been identified in the ARAR table (see Appendix C).

Section XIII.B of the Amended Consent Agreement requires the DOE to identify those permits that would otherwise be required, along with the standards, requirements, criteria, or limitations that would have to have been met to obtain each permit. The DOE must report these findings to the USEPA, along with an explanation of how the response action will meet these standards, requirements, criteria, or limitations.

The following summarizes the permits, permit requirements, and plans to meet those requirements for Phase II operations.

16.4.1 Air Permits

Compliance with existing Permits to Operate (PTOs) for Silos 1 and 2 will be maintained.

Construction and Phase II operation of the Pilot Plant may generate nuisance dust during construction, and off-gases from operating the vitrification furnace to melt the waste materials. Releases of dust and particulates will be controlled by approved site standard operating procedures and best available technology, including off-gas control equipment.

A. Identification of Air Permits That Would Otherwise be Required

Federal Permits

NATIONAL EMISSION STANDARDS FOR HAZARDOUS AIR POLLUTANTS (NESHAP) - 40 CFR PART 61, SECTION 61.07(a): The owner or operator shall submit to the Administrator an application for approval of the construction of any new source or modification of any existing source. Unless exempted in a specific subpart, an application for approval would have to be submitted for sources subject to a National Emission Standards for Hazardous Air Pollutants

(NESHAP) standard. The Operable Unit 4 Pilot Plant is subject to the requirements of Subpart H of 40 CFR Part 61.

40 CFR PART 61, SUBPART H - NATIONAL EMISSION STANDARDS FOR EMISSIONS OF RADIONUCLIDES OTHER THAN RADON FROM DOE FACILITIES - Section 61.96(b) states that an application for approval does not have to be filed for radionuclide sources if the effective dose equivalent (EDE) caused by all emissions from the new construction or modification is less than 0.1 mrem per year. Emissions from the Pilot Plant have not yet been determined. The EDE shall be determined using an approved USEPA computer model. The source term to be entered into the model, to determine the necessity of an application, shall be developed using Appendix D to Part 61 - Methods for Estimating Radionuclides.

40 CFR PART 61, SUBPART Q - NATIONAL EMISSION STANDARDS FOR RADON EMISSIONS FROM DOE FACILITIES - Subpart Q does not provide an exemption for new construction or modifications having the potential to emit radon. Ordinarily, an application would have to be submitted for approval. Only radon released from interim storage facilities and during storage of vitrified material is subject to the requirements of 40 CFR Part 61 Subpart Q.

State Permits

PERMIT TO INSTALL - Ohio Administrative Code (OAC) 3745-31-02 (A): Unless exempted by OAC 3745-31-03, no person shall cause, permit or allow the installation of a new source of air pollutants or cause, permit, or allow the modification of an air contaminant source without first obtaining a Permit to Install. Under ordinary circumstances, an air Permit to Install would have to be obtained for the proposed vitrification Pilot Plant.

PERMITS TO OPERATE - OAC 3745-35-02 (A): Except as otherwise provided in paragraph H (Conditional Permits to Operate) of rule OAC 3745-35-02 and in OAC rules 3745-35-03 (variances) and 3745-35-05 (permit exemptions and registration status), no person may cause, permit, or allow the operation or other use of any air contaminant source without first applying for and obtaining a Permit to Operate. Under ordinary circumstances, Permits to Operate would have to be obtained for the proposed vitrification Pilot Plant.

B. Identification of the Standards, Requirements, Criteria, or Limitations that Would Have to be Met to Obtain the Above Permits/Notifications

Federal Requirements

NESHAP SUBPART H - 40 CFR PART 61, SECTION 61.92: Emissions of radionuclides (except radon^{222} and radon^{220}) to the ambient air from Department of Energy facilities shall not exceed those amounts that would cause any member of the public to receive in any year an effective dose equivalent of 10 mrem/yr.

NESHAP SUBPART H - 40 CFR PART 61, SECTION 61.93: Continuous measurement of radionuclide emissions is required for point sources having the potential to cause an EDE in excess of 0.1 mrem/yr. The EDE is again determined by an approved USEPA computer model. However, for the purposes of determining monitoring requirements, the estimated radionuclide release rates are based on normal facility operations, without the benefit of any pollution control equipment. Additionally, all radionuclides which could contribute greater than 10% of the potential EDE for a release point shall be measured.

NESHAP SUBPART Q - 40 CFR PART 61, SECTION 61.192: No source at a Department of Energy facility shall emit more than 20 pCi/-m^2-s of radon^{222} as an average for the entire source, into the air. This applies to the design and operation of DOE owned storage and disposal facilities that emit radon^{222} into the air.

<u>State Requirements</u>

PERMIT TO INSTALL - OAC 3745-31-05 (A): Installation of the proposed Pilot Plant facility must not prevent or interfere with the attainment or maintenance of applicable ambient air quality standards; and must not result in a violation of any applicable laws; and must employ the best available technology (BAT) to control emissions.

PERMITS TO OPERATE - OAC 3745-35-02 (C): The proposed Pilot Plant facility must be operated in compliance with applicable air pollution control law; must be constructed, located or installed in compliance with the terms and conditions of a Permit to Install; and must not violate NESHAPs adopted by the Administrator of the USEPA.

C. <u>Explanation of How the Response Action Will Meet the Standards, Requirements, Criteria, or Limitations Identified in Item B Above</u>

<u>NESHAP Subpart H:</u>

The Pilot Plant emission control systems will be designed to prevent the facility from exceeding the 10 mrem/yr EDE standard. Emissions from the vitrification facility shall be vented through a vitrification off-gas system. Radon emissions from the silos shall be vented through a carbon bed/HEPA filter control system.

A stack monitoring program will be established for the vitrification exhaust gases. This monitoring program will conform to the sample collection and analytical requirements of 40 CFR Part 61, Appendix B, Method 114. An isokinetic sampler shall be used to continuously withdraw a sample from the stack. The sample will be drawn through a filter to collect particulate matter for analysis. Using the results of the sample analyses, the annualized EDE shall be determined using an approved computer model and shall be incorporated into the sitewide annual NESHAP report.

Though not yet modeled, preliminary estimates of the source term derived under 40 CFR Part 61.96(b), indicate that the EDE will be greater than 0.1 mrem/yr. This, normally, would require the submittal of an application for approval.

The EDE used to evaluate stack monitoring requirements has not been calculated, though it is also expected to be greater than 0.1 mrem/yr. A continuous, isokinetic stack sampler will be installed to measure emissions from the vitrification process.

NESHAP Subpart Q:

Data from the treatability study indicate that radon emissions from storage of the vitrified product will be less than 20 pCi/m^2/s. This will comply with the requirements of 40 CFR Part 61 Subpart Q.

Estimates of both Subpart H and Subpart Q emissions from the Pilot Plant project are being developed. These emission estimates, and the results of any associated computer modeling runs will be forwarded to the USEPA as a separate document.

The off-gas system, described in Section 4.7, is being designed to meet the requirements of Best Available Technology for control of emissions. The vitrification unit will be heated electrically, and as such, will not be a major source of criteria pollutants. The material to be processed contains limited amounts of compounds which could produce an air toxic hazard. Ambient air quality will not be adversely impacted by emissions from this source.

The Pilot Plant will be operated in such a manner so as to not interfere with the attainment or maintenance of any applicable air quality standards, nor cause a violation of any applicable laws.

16.4.2 Wastewater Permits

This project will result in the generation of wastewater which will be discharged to the FEMP Advanced Waste Water Treatment System (AWWTS) under the NPDES permit.

Generated wastewater streams will include the combined discharge of process wastewaters and the accumulations of rain water from diked concrete pads in the Pilot Plant area. This wastewater stream will be characterized to determine the appropriate means of treatment in the site AWWTS, with the treated effluent being discharged under the NPDES permit.

Also, under the Clean Water Act (CWA), permits are required for activities which discharge material into U.S. waters (including wetlands). Although the Pilot Plant will not be constructed in a wetland area, some wetland areas will be impacted by the installation of several utility lines to serve the proposed Pilot Plant.

A. Identification of Wastewater Permits that Would Otherwise be Required

Federal Permits

CLEAN WATER ACT - SECTION 404: Pursuant to Section 404 of the Clean Water Act (CWA), a permit from the U.S. Army Corps of Engineers (ACOE) would be required to discharge materials into the wetland areas.

State Permits

PERMITS TO INSTALL - OAC 3745-31-02 (A): Unless exempted by OAC 3745-31-03, no person shall cause, permit or allow the installation of a new disposal system, or cause, permit, or allow the modification of a disposal system without first obtaining a Permit to Install. Under ordinary circumstances, a wastewater Permit to Install would have to be obtained for the proposed vitrification Pilot Plant.

NATIONAL POLLUTANT DISCHARGE ELIMINATION SYSTEM (NPDES) - OAC 3745-33-02 (A): No person may discharge any pollutant or cause, permit, or allow a discharge of any pollutant without applying for and obtaining an Ohio NPDES permit. The FEMP currently operates under an approved Ohio NPDES permit.

SECTION 401 WATER QUALITY CERTIFICATIONS - OAC 3745-32-02(A)(2): A Section 401 State Water Quality Certification is required to obtain a Section 404 permit from the ACOE.

B. Identification of the standards, requirements, criteria, or limitations that would have to be met to obtain the above permits/notifications

Federal Requirements

CLEAN WATER ACT - SECTION 404: The temporary sidecasting (up to three months) of excavated material into wetlands during construction of utility lines is authorized under Nationwide Permit (NWP) 12 as codified in Appendix B to 33 CFR Part 330, provided the following permit conditions are met:

- Navigation. The activity must not cause more than a minimal effect on navigation.
- Proper Maintenance. Fill authorized by the NWP must be properly maintained, including maintenance to ensure public safety.
- Erosion and Siltation Controls. Appropriate erosion and siltation controls must be used and maintained in effective operating condition during construction, and all exposed soil and other fills must be permanently stabilized at the earliest possible date.
- Aquatic Life Movements. The activity must not disrupt the movement of those species of aquatic life indigenous to the body of water (wetland) where the activity is being conducted.
- Equipment. Heavy equipment working in wetlands must be placed on mats or other measures must be taken to minimize soil disturbance.
- Wild and Scenic Rivers. The activity can not occur in a component of the National Wild and Scenic River System.
- Tribal Indian Rights. The activity must not impair reserved tribal rights including but not limited to reserved water rights and treaty fishing and hunting rights.

- Water Quality Certification. A State Water Quality Certification or waiver thereof is required.

- Endangered Species. The activity must not jeopardize the continued existence of any threatened or endangered species or adversely affect their habitats in any manner.

- Historic Properties. The activity must not affect historic properties listed or eligible for listing in the National Register of Historic Places.

- Water Supply Intakes. The discharge of excavated material must not occur in close proximity of a public water supply intake.

- Shellfish Production. No discharge of material is allowed in an area of concentrated shellfish production.

- Suitable Material. The discharged material must be free of unsuitable materials (trash, debris, etc.) and toxic pollution in toxic amounts as per Section 307 of the CWA.

- Mitigation. The discharge of material must be minimized or avoided to the maximum extent practicable at the project site.

- Spawning Areas. Discharges in spawning areas during spawning season must be limited to the maximum extent practicable.

- Obstruction of High Flows. To the maximum extent practicable, discharges must not permanently restrict or impede the passage of normal or expected high flows or cause relocation of the water.

- Waterfowl Breeding Areas. Discharge into breeding areas for migratory waterfowl must be avoided to the maximum extent practicable.

- Removal of Temporary Fills. Any temporary fills must be removed in their entirety and the affected areas returned to their preexisting contours.

<u>State Requirements</u>

PERMITS TO INSTALL - OAC 3745-31-05 (A): Installation of the proposed Pilot Plant facility must not prevent or interfere with the attainment or maintenance of applicable ambient water quality standards; and must not result in a violation of any applicable laws; and must employ the best available technology.

NATIONAL POLLUTANT DISCHARGE ELIMINATION SYSTEM (NPDES) - OAC 3745-33-02 (A): All discharges authorized under the NPDES permit shall be consistent with the terms and conditions of the permit. Facility expansions, production increases, or process modifications which result in new, different or increased discharges of pollutants must be reported.

SECTION 401 WATER QUALITY CERTIFICATIONS - OAC 3745-32-02(A)(2): The Ohio Environmental Protection Agency (OEPA) granted Section 401 State Water Quality Certification for NWP 12 on January 17, 1992. Work conducted under NWP 12 need only comply with the following conditions of the Water Quality Certification to be authorized.

- Bank Stabilization. All necessary steps shall be taken, upon completion of the project, to ensure bank stability.

- Damages to Immediate Environment. All damage by equipment needed for construction or hauling shall be repaired immediately.

- Water Quality. Care must be employed throughout the course of the project to avoid the creation of unnecessary turbidity which may degrade water quality or adversely affect aquatic life.

- Forested Wetlands. NWP 12 can not be used to authorize utility lines greater than 1000 feet in length in forested wetlands.

C. Explanation of How the Response Action Will Meet the Standards, Requirements, Criteria, or Limitations Identified in Item B Above

Federal Requirements

The proposed project will be conducted in compliance with the conditions of NWP 12 as follows:

- Navigation. The proposed project will not affect navigation.

- Proper Maintenance. Any fill discharged as a result of the project will be maintained and stabilized as soon as practicable upon completion of the project.

- Erosion and Siltation Controls. Appropriate erosion and siltation controls will be used and maintained in effective operating condition during construction, and all exposed soil and other fills will be permanently stabilized at the earliest possible date after completion of construction.

- Aquatic Life Movements. Construction will not disrupt the movement of any indigenous aquatic species.

- Equipment. When heavy equipment must be used to conduct work within the wetland mats, other measures will be utilized to minimize disturbance within the wetland area.

- Wild and Scenic Rivers. The wetland in which work will be conducted is not part of the National Wild and Scenic River System.

- Tribal Indian Rights. The project will not impair reserved tribal Indian rights in any manner.

- Water Quality Certification. OEPA granted State Water Quality Certification for NWP 12 on January 17, 1992.

- Endangered Species. No known threatened or endangered species inhabit the area in which work will be conducted.

- Historic Properties. The project will not affect any historic properties which are listed or eligible for listing in the National Register of Historic Places.

- Water Supply Intakes. There are no public water supply intakes in close proximity to the proposed project location.

- Shellfish Production. The project will not be conducted in an area of concentrated shellfish production.

- Suitable Material. All material discharged during the course of the project will be free of unsuitable materials (trash, debris, etc.) and toxic pollution in toxic amounts as per Section 307 of the CWA.

- Mitigation. Impacts to the wetland area will be minimized to the maximum extent practicable during construction. Disturbances will be allowed only in those areas in which they are absolutely required.

- Spawning Areas. The proposed project is not being conducted in a spawning area.

- Obstruction of High Flows. The project will not result in the permanent restriction or impediment of flows within the wetland. All fill discharged into the wetland will be removed with three (3) months.

- Waterfowl Breeding Areas. The project area is not known to be a breeding area for migratory waterfowl.

- Removal of Temporary Fills. All fill material will be removed from the wetland area immediately upon completion of construction and the affected wetland areas will be returned to their pre-existing contour elevations. In addition, any exposed areas will be stabilized as soon as practicable.

<u>State Requirements</u>

This project will not interfere with the attainment or maintenance of any water quality standards; nor will it result in a violation of any applicable laws. Wastewater streams generated by the vitrification process will not significantly alter the character of the plant effluent streams. Best available technology will be satisfied with the installation of a filter used for the removal of suspended solids. Effluent from the filter will be discharged to existing systems for the treatment necessary to meet current NPDES effluent limitations.

The proposed project will comply with all conditions of the Section 401 State Water Quality Certification for NWP 12 as follows:

- Bank Stabilization. All necessary steps will be taken, upon completion of the project, to ensure bank stability.

- Damages to Immediate Environment. All damage cause by equipment needed for construction or hauling will be repaired immediately, upon completion of construction.

- Water Quality. Care will be taken to avoid the creation of unnecessary turbidity which may degrade water quality or adversely affect aquatic life.

- Forested Wetlands. The proposed project does not involve work within a forested wetland.

16.5 APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS (ARARs)

Activities of this Pilot Plant program include the potential for generation of wastewater streams, emission of radionuclides, off-gas emissions and the generation of RCRA hazardous waste, or waste sufficiently similar to RCRA waste to require regulation under RCRA, as discussed in Section 16.3. In addition, there is the potential for the generation of dust particulates and other emissions as the result of construction and operation of the waste retrieval systems and vitrification facility, and for generation of additional waste streams needing characterization.

Applicable or relevant and appropriate requirements (ARARs) and To Be Considered (TBC) criteria which pertain to the types of contaminants that may be generated, or the location of activities associated with the Pilot Plant, have been identified. Appendix C presents the potential regulatory requirements for this project and the compliance strategies associated with each requirement.

17.0 REFERENCES

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APPENDIX A

Operable Unit 4 Characterization of Untreated Silo Residues

TABLE A.1-1

SUMMARY OF RADIONUCLIDE ANALYSES FOR SILOS 1 AND 2 RESIDUES

Analyte[a]	Frequency of Detection[b]	Rejected	Arithmetic Mean[c] (pCi/g)[d]	Upper 95% CI on Mean[c] (pCi/g)[d]	Range of Detects[c] (pCi/g)[d]
SILO 1					
Actinium-227	13/20	0	5960	7670	4320-17390
Lead-210	20/20	0	165000	202000	48980-381400
Polonium-210	13/13	0	242000	281000	144000-434000
Radium-226	20/20	0	391000	477000	89280-890700
Thorium-228	2/20	0	422	2280	835-2280
Thorium-230	24/24	0	60000	68900	10569-105372
Thorium-232	8/20	0	424	1110	661-1106
Uranium-234	21/21	0	800	932	326-1548
Uranium-235/236	14/20	0	38	54	19.1-105
Uranium-238	20/20	0	642	693	387-920
SILO 2					
Actinium-227	11/14	0	5100	6640	2905-10450
Lead-210	14/14	0	145000	190000	58160-399200
Polonium-210	8/8	0	139000	231000	55300-241000
Protactinium-231	1/14	0	2350	4040	4041-4041
Radium-226	14/14	0	195000	263000	657-481000
Thorium-228	5/14	0	645	7360	411-7360
Thorium-230	15/15	0	48400	76200	8365-132800
Thorium-232	3/14	0	402	985	851-985
Uranium-234	13/13	0	961	1160	121-1465
Uranium-235/236	11/13	0	73	94	35.6-172
Uranium-238	14/14	0	912	1120	46-1925

[a]Sample numbers used in this data set include: (Silo 1) 99728, 99743, 99870, 99885, 99909, 99930, 99939, 99948, 99966, 99975, 100004, 100025, 100039, 100108 through 100114; and (Silo 2) 99359, 99710, 99774, 99802, 99811, 99831, 99846, 99861, and 100115 through 100120.
[b]Rejected data not included in total number of samples.
[c]Values qualified with an R are excluded. The mean and upper 95% confidence interval (CI) on mean have been rounded to show three significant figures. The mean is calculated using one-half the Sample Quantitation Limit (SQL) for nondetects.
[d]Values expressed in picoCuries per gram (pCi/g).

TABLE A.1-2

INVENTORY OF K-65 RADIOLOGICAL CONSTITUENTS

	Silo 1[a]		Silo 2[b]	
Analyte	Mean Inventory[c] (Ci)	UCL Inventory[c] (Ci)	Mean Inventory[c] (Ci)	UCL Inventory[c] (Ci)
Actinium-227	40	52	30	39
Lead-210	1110	1360	844	110
Polonium-210	1630	1890	809	1340
Protactinium-231	ND[d]	ND[d]	14	24
Radium-226	2630	3210	1140	1530
Thorium-228	2.8	15.3	3.8	43
Thorium-230	403	463	282	444
Thorium-232	2.9	7.5	2.3	5.7
Uranium-234	5.4	6.3	5.6	6.8
Uranium-235/236	0.26	0.36	0.43	0.55
Uranium-238	4.3	4.7	5.3	6.5
Total Uranium[e]	12.9	14.1	15.9	19.5

[a]Based on a volume of 3280 cubic meters (m^3) and a dry mass density of 2.050 grams per cubic centimeter (gm/cm^3).
[b]Based on a volume of 2840 m^3 and a dry mass density of 2.050 gm/cm^3.
[c]Values for mean and Upper Confidence Limit (UCL) calculated using value taken from Table 4-2 of the Remedial Investigation Report for Operable Unit 4 (RI Report for OU4).
[d]ND - Analyte was not detected.
[e]Total uranium mass values in metric tons (MT). Calculated from the isotopic distribution of uranium.

TABLE A.1-3

CHEMICAL ANALYSES
FOR SILOS 1 AND 2 RESIDUES

Analyte[a]	Frequency of Detection[b]	Rejected	Arithemetic Mean[c] (mg/kg)[d]	Upper 95% CI on Mean[c] (mg/kg)[d]	Range of Detection (mg/kg)[d]
SILO 1					
General Chemistry					
Ammonia	4/7	0	1.19	8.9	1.1-8.9
Chloride	7/7	0	637	1340	269-1349
Fluoride	2/7	0	1	394	15-394
Nitrate	5/5	2	2930	4764	2216-4764
Oil and grease	7/8	0	3650	27000	11.7-27000
Phosphorus	8/8	0	1130	3290	0.4-3290
Sulfate	6/6	1	1300	3460	444-3460
Total Kjeldahl nitrogen	7/7	0	479	676	51.6-782.5
Total organic carbon	8/8	0	19200	26200	5166-34800
Total organic nitrogen	8/8	0	448	623	51.6-782
Metals					
Aluminum	13/19	0	1050	1320	450-2460
Antimony	11/12	7	21	26	13.3-46.2
Arsenic	18/19	0	22	55	3.1-68.4
Barium	19/19	0	11600	14200	1970-22100
Beryllium	17/19	0	1	1	0.59-2.8
Boron	12/12	0	46	50	23.8-61.7
Cadmium	11/18	1	2	4	0.56-8
Calcium	19/19	0	2960	3650	799-5700
Chromium	19/19	0	42	55	19.7-165
Cobalt	19/19	0	936	1100	349-1870
Copper	19/19	0	285	331	122-475
Cyanide	19/19	0	2	3	0.52-4.4
Iron	19/19	0	14700	21100	4280-75100
Lead	19/19	0	81700	95500	17400-133000
Magnesium	19/19	0	2880	3380	1500-6020
Manganese	19/19	0	72	97	25.6-257
Mercury	18/19	0	0.6	0.9	0.15-2.8

TABLE A.1-3
(Continued)

Analyte[a]	Frequency of Detection[b]	Rejected	Arithemetic Mean[c] (mg/kg)[d]	Upper 95% CI on Mean[c] (mg/kg)[d]	Range of Detection (mg/kg)[d]
Molybdenum	12/12	0	4850	6290	968-8600
Nickel	19/19	0	1790	2290	629-3380
Potassium	19/19	0	429	493	158-715
Selenium	19/19	0	287	340	58.5-2810
Silicon	12/12	0	723	853	359-1290
Silver	19/19	0	11	13	5-23.3
Sodium	19/19	0	8670	10700	360-16700
Thallium	8/18	1	0.3	1.4	0.09-1.4
Vanadium	19/19	0	136	161	63.1-293
Zinc	14/19	0	28	37	7.7-212
SILO 2					
General Chemistry					
Chloride	6/6	0	65	141	28-141
Nitrate	5/5	1	5430	8900	3490-8900
Oil and grease	4/4	0	301	541	207-541
Phosphorus	5/5	0	1130	1400	623-1400
Sulfate	6/6	0	8610	19300	2590-19300
Total Kjeldahl nitrogen	3/3	0	204	220	176-220
Total organic carbon	5/5	0	6090	24400	148-24400
Total organic nitrogen	4/4	1	232	289	176-289
Metals					
Aluminum	8/14	0	845	1110	363-2250
Antimony	7/8	6	26	44	14.4-77.4
Arsenic	14/14	0	432	1550	57.5-1960
Barium	14/14	0	6970	19900	89.2-19900
Beryllium	14/14	0	2	3	0.59-6
Boron	5/8	0	38	51	18.4-81.2
Cadmium	13/14	0	5	7	2-19.1
Calcium	14/14	0	33300	301000	64-301000
Chromium	14/14	0	40	51	0.207-83.1
Cobalt	14/14	0	984	2430	6.2-2430
Copper	13/13	1	531	818	220-1790

TABLE A.1-3
(Continued)

Analyte[a]	Frequency of Detection[b]	Rejected	Arithemetic Mean[c] (mg/kg)[d]	Upper 95% CI on Mean[c] (mg/kg)[d]	Range of Detection (mg/kg)[d]
Cyanide	13/13	1	3	5	0.9-7.1
Iron	13/13	1	16500	28900	4010-40000
Lead	14/14	0	48200	299000	153-299000
Magnesium	14/14	0	3800	6410	805-8740
Manganese	14/14	0	163	259	40.6-403
Mercury	13/13	1	0.9	1.2	0.18-2.3
Molybdenum	8/8	0	291	440	148-479
Nickel	14/14	0	1380	1720	14.6-2640
Potassium	14/14	0	217	337	37.8-653
Selenium	13/13	1	110	124	49.6-155
Silicon	8/8	0	851	1148	507-1780
Silver	13/13	1	17	22	7.4-34.9
Sodium	14/14	0	2430	3200	226-4940
Thallium	9/12	1	1	2	0.33-5.7
Vanadium	14/14	0	237	298	21.9-535
Zinc	14/14	0	54	91	11.2-159

[a]Sample numbers used in this data set include: 99359, 99704-99806, 99711-99713, 99715, 99718, 99769-99771, 99775-99778, 99781, 99723-99725, 99729-99732, 99735, 99738-99740, 99745-99747, 99750, 99806-99808, 99812-99815, 99818, 99826-99828, 99832-99834, 99837, 99839, 99841-99843, 99847-99850, 99853, 94856-99858, 99865-99867, 99871-99874, 99877, 99880-99882, 99886-99889, 99904-99906, 99910-99913, 99916, 99925-99927, 99934-99936, 99940-99943, 99946, 99963-99965, 99980-99984, 99986, 99987, 99999, 100000, 100001, 100026-100029, 100032, 100034-100036, and 100115-100120.

[b]Rejected data not included in total number of samples.

[c]Values qualified with an R are excluded. The mean and upper 95% CI on mean has been rounded to show three significant figures. The mean is calculated using one-half the SQL for nondetects.

[d]Values expressed in milligrams per kilogram (mg/kg).

TABLE A.1-4

ORGANICS ANALYSES FOR SILO 1 RESIDUES

Analyte[a]	Frequency of Detection[b]	Rejected	Arithmetic Mean[c] (mg/kg)[d]	Upper 95% CI on Mean[c] (mg/kg)[d]	Range of Detection[c] (mg/kg)[d]
PCBs and Pesticides					
4,4'-DDT	2/19	0	0.21	0.07	0.014-0.068
4,4'-DDE	2/19	0	0.22	0.12	0.029-0.12
Aldrin	1/19	0	0.09	0.056[e]	e
Aroclor-1248	3/17	2	1.2	2	1.7-10
Aroclor-1254	17/17	2	7.4	10	1.1-20
Aroclor-1260	2/19	0	2.6	3.5	1.3-3.5
Dieldrin	1/19	0	0.21	0.093[e]	e
Endosulfan-I	2/19	0	0.1	0.092	0.011-0.092
Endosulfan II	2/19	0	0.22	0.26	0.082-0.26
Endrin	1/19	0	0.2	0.089[e]	e
Heptachlor epoxide	2/19	0	0.11	0.2	0.022-0.2
Semivolatile Organics					
Benzoic acid	4/12	7	0.53	0.12	0.075-0.12
Bis(2-Ethylhexyl)phthalate	12/16	3	0.7	1.5	0.07-6
Di-n-butylphthalate	2/19	0	0.21	0.057	0.046-0.057
Di-n-octylphthalate	8/19	0	0.3	0.97	0.045-0.97
Dimethyl phthalate	5/12	7	0.16	0.16	0.068-0.16
N-nitroso-di-n-propylamine	1/12	7	0.24	0.059[e]	e
Phenol	1/12	7	0.28	0.4[e]	e
Tributyl phosphate	9/9	2	15	51	0.2-51
Volatile Organics					
2-Butanone	4/11	7	0.007	0.022	0.002-0.022
2-Hexanone	6/11	7	0.007	0.017	0.002-0.017
4-Methyl-2-pentanone	3/11	7	0.005	0.003	0.002-0.003
Acetone	6/11	7	0.05	0.15	0.064-0.15
Methylene chloride	2/11	7	0.02	0.19	0.0380-0.19
Toluene	4/11	7	0.02	0.05	0.002-0.19

[a]Sample numbers used in this data set include: 99733, 99875, 99914, 99931, 99944, 99722, 99733, 99737, 99748, 99864, 99875, 99879, 99890, 99903, 99914, 99924, 99931, 99933, 99944, 99958, 99959, 99977, 99979, 99890, 100009, 100019, 100030, 100033, 100040, and 100108 through 100114.
[b]Rejected data not included in total number of samples.
[c]Values qualified with an R are excluded. The mean and upper 95% CI on mean has been rounded to show three significant figures. The mean is calculated using one-half the SQL for nondetects.
[d]Values expressed in milligrams per kilogram (mg/kg).
[e]Analyte was detected in a single sample.

TABLE A.1-5

SUMMARY OF ORGANICS ANALYSES FOR SILO 2 RESIDUES

Analyte[a]	Frequency of Detection[b]	Rejected	Arithmetic Mean[c] (mg/kg)[d]	Upper 95% CI on Mean[c] (mg/kg)[d]	Range of Detection[c] (mg/kg)[d]
PCBs and Pesticides					
Aroclor-1254	8/8	6	6.6	15	0.42-15
Aroclor-1260	1/14	0	1.4	0.034[e]	e
Semivolatile Organics					
Benzoic acid	3/9	4	0.57	0.39	0.076-0.39
Bis(2-ethylhexyl)phthalate	8/8	5	0.55	1.2	0.19-1.9
Diethyl phthalate	1/7	6	0.24	0.41[e]	e
Fluoranthene	1/13	0	0.18	0.064[e]	e
N-nitroso-di-n-propylamine	3/7	6	0.17	0.26	0.083-0.26
Pyrene	1/13	0	0.17	0.047[e]	e
Tributyl phosphate	5/5	1	29	73	7.5-73
Volatile Organics					
2-Butanone	1/7	7	0.007	0.01[e]	e
Acetone	3/7	7	0.02	0.07	0.033-0.072
Carbon tetrachloride	1/8	6	0.005	0.17[e]	e
Methylene chloride	2/8	6	0.013	0.047	0.015-0.047
Tetrachloroethene	1/8	6	0.005	0.14[e]	e
Toluene	1/8	6	0.008	0.01[e]	e
Total xylenes	1/7	7	0.006	0.003[e]	e

[a]Sample numbers used in this data set include: 99359, 99701, 99702, 99768, 99779, 99796, 99803, 99805, 99816, 99825, 99835, 99840, 99851, 99855, 99862, and 100115-100120.
[b]Rejected data not included in total number of samples.
[c]Values qualified with an R are excluded. The mean and upper 95% CI on mean has been rounded to show three significant figures. The mean is calculated using one-half the SQL for nondetects.
[d]Values expressed in milligrams per kilogram (mg/kg).
[e]Analyte detected in a single sample.

TABLE A.1-6

EP TOXICITY RESULTS FOR SILOS 1 AND 2 RESIDUES - 1989[a]

Analyte[b]	Frequency of Detection	Mean (mg/L)	Standard Deviation (mg/L)	Minimum (mg/L)	Maximum (mg/L)	Maximum Concentration of Contaminants[c] (mg/L)
Silo 1						
Arsenic	6/7	0.312	0.144	ND[d]	0.484	5.0
Barium	7/7	4.362	4.399	0.079	14.5	100.0
Cadmium	6/7	0.027	0.031	ND	0.1	1.0
Chromium	7/7	0.333	0.277	0.02	0.964	5.0
Lead	7/7	561	278	0.159	904	5.0
Mercury	0/7	ND	ND	ND	ND	0.2
Selenium	7/7	0.535	0.238	0.217	0.997	1.0
Silver	6/7	0.074	0.040	ND	0.121	5.0
Silo 2						
Arsenic	6/6	0.389	0.137	0.163	0.592	5.0
Barium	6/6	1.087	0.755	0.095	2.62	100.0
Cadmium	6/6	0.102	0.091	0.017	0.278	1.0
Chromium	4/6	0.380	0.365	ND	1.02	5.0
Lead	6/6	322	266	0.155	714	5.0
Mercury	0/6	ND	ND	ND	ND	0.2
Selenium	6/6	0.705	0.488	0.24	1.56	1.0
Silver	4/6	0.087	0.076	ND	0.213	5.0

[a]The data presented in table have not been validated.
[b]The sample numbers used in this data set include: (Silo 1) MM3336 through MM3343; (Silo 2) MM3340 through MM3348.
[c]Data obtained from 40 CFR 261.24.
[d]ND - Not detected

TABLE A.1-7

SUMMARY OF TCLP METALS ANALYSES FOR SILO 1 RESIDUES - 1990/1991

Analyte[a]	Frequency of Detection[b]	Rejected	Mean[c] (mg/L)[d]	Standard Deviation[c] (mg/L)[d]	Range[c] (mg/L)[d]	Maximum Allowable Concentration
Aluminum	12/12	0	0.314	0.067	0.228-0.441	g
Antimony	12/12	0	0.093	0.019	0.067-0.129	g
Arsenic	1/11	1	0.002	e	e	5.0
Barium	12/12	0	0.868	0.402	0.348-1.83	100.0
Beryllium	6/12	0	0.002	0.0004	0.002-0.003	g
Boron	11/12	0	0.255	0.070	0.168-0.384	g
Cadmium	12/12	0	0.003	0.001	0.002-0.005	1.0
Calcium	12/12	0	55.4	33.6	17.6-108	g
Chromium	12/12	0	0.059	0.012	0.045-0.081	5.0
Cobalt	12/12	0	1.82	0.89	0.72-3.06	g
Copper	12/12	0	0.208	0.097	0.068-0.404	g
Iron	10/12	0	0.046	0.022	0.018-0.1	g
Lead	8/9	3	614	221	229-841	5.0
Magnesium	12/12	0	8.96	2.00	6.12-13.8	g
Manganese	12/12	0	0.163	0.070	0.067-0.308	g
Mercury	1/12	0	0.0002	e	e	0.2
Molybdenum	12/12	0	0.072	0.026	0.036-0.108	g
Nickel	12/12	0	3.18	1.39	1.32-5.57	g
Potassium	12/12	0	10.3	5.32	2.95-18.3	g
Selenium	11/11	1	0.135	0.088	0.015-0.306	1.0
Silicon	12/12	0	31.9	8.2	13.5-42.1	g
Silver	12/12	0	0.034	0.008	0.023-0.048	5.0
Thallium	9/12	0	0.005	0.003	0.002-0.009	g
Vanadium	12/12	0	0.023	0.005	0.017-0.032	g
Zinc	12/12	0	0.128	0.079	0.02-0.323	g

[a]The sample numbers used in this data set include: 99727,99742,99869,99884,99908,99929,99938, 99967, 99985, 100003, 100024, and 100038.

[b]Rejected data not included in total number of samples.

[c]Values qualified with an R, U, or UJ are excluded. The mean and standard deviation have been rounded to show no more than three significant figures.

[d]Values expressed in milligrams per liter (mg/L).

[e]Analyte was detected in a single sample.

[f]Data obtained from 40 CFR 261.24.

[g]No standard Maximum Allowable Concentrations (MAC) specified in 40 CFR 261.24.

TABLE A.1-8
SUMMARY OF TCLP ORGANICS ANALYSES FOR SILO 1 RESIDUES - 1990/1991

Analyte[a]	Frequency of Detection[b]	Rejected	Mean[c] (mg/L)[d]	Standard Deviation[c] (mg/L)[d]	Range[c] (mg/L)[d]	Maximum Allowable Consentration[f]
PCBs and Pesticides						
None detected						
Semivolatile Organics						
4-Chloro-3-methylphenol	1/10	1	0.004	e	e	g
4-Nitrophenol	1/11	0	0.008	e	e	g
Benzoic acid	4/10	1	0.049	0.048	0.006-0.1	g
Bis(2-Ethylhexyl)phthalate	2/10	1	0.052	0.065	0.006-0.098	g
Di-n-octylphthalate	4/10	1	0.021	0.002	0.005-0.05	g
N-Nitroso-di-n-propylamine	4/10	1	0.127	0.116	0.018-0.28	g
Volatile Organics						
2-Butanone	7/9	2	0.005	0.003	0.001-0.01	200.0
4-Methyl-2-pentanone	8/11	0	0.002	0.003	0.001-0.01	g
Acetone	9/10	1	0.223	0.153	0.069-0.49	g
Methylene chloride	9/11	0	0.018	0.010	0.009-0.038	g
Tetrachloroethene	1/5	6	0.001	e	e	0.7
Toluene	5/11	0	0.002	0.002	0.001-0.005	g

[a]The sample numbers used in this data set include: 99726, 99734, 99741, 99749, 99868, 99876, 99883, 99891, 99907, 99915, 99928, 99932, 99937, 99945, 99960, 99962, 99976, 100010, 100023, 100031, 100037, and 100041.
[b]Rejected data not included in total number of samples.
[c]Values qualified with an R, U, or UJ are excluded. The mean and standard deviation have been rounded to show no more than three significant figures. The range has been rounded to the nearest thousandth, unless a fourth decimal place is required to show a value.
[d]Values expressed in milligrams per liter (mg/L).
[e]Analyte detected in a single sample.
[f]Data obtained from 40 CFR 261.24.
[g]No standard MAC specified in 40 CFR 261.24.

TABLE A.1-9

SUMMARY OF TCLP METALS ANALYSES FOR SILO 2 RESIDUES - 1990/1991

Analyte[a]	Frequency of Detection[b]	Rejected	Mean[c] (mg/L)[d]	Standard Deviation[c] (mg/L)[d]	Range[c] (mg/L)[d]	Maximum Allowable Concentration[e]
Aluminum	7/7	0	1.29	0.763	0.462-2.75	f
Antimony	6/6	1	0.096	0.018	0.079-0.123	f
Arsenic	8/8	0	0.064	0.110	0.003-0.32	5.0
Barium	8/8	0	2.96	3.30	0.157-8.47	100.0
Beryllium	7/7	0	0.005	0.0007	0.003-0.006	f
Boron	4/4	0	0.69	0.58	0.24-1.5	f
Cadmium	7/7	1	0.047	0.028	0.010-0.077	1.0
Calcium	7/7	0	483	276	163-975	f
Chromium	8/8	0	0.129	0.036	0.086-0.207	5.0
Cobalt	7/7	0	3.02	2.11	1.18-6.16	f
Copper	7/7	0	1.41	1.41	0.274-3.86	f
Iron	7/7	0	0.076	0.012	0.053-0.090	f
Lead	7/7	1	516	348	117-1072	5.0
Magnesium	7/7	0	15.4	8.84	7.39-29.6	f
Manganese	7/7	0	0.776	0.466	0.409-1.62	f
Molybdenum	7/7	0	0.058	0.027	0.034-0.099	f
Nickel	7/7	0	3.48	1.45	2.04-5.77	f
Potassium	5/7	0	4.032	1.18	2.64-5.31	f
Selenium	8/8	0	0.114	0.184	0.026-0.568	1.0
Silicon	5/5	1	16.3	5.2	12.1-24.3	f
Silver	8/8	0	0.093	0.032	0.053-0.164	5.0
Thallium	6/7	0	0.009	0.011	0.0022-0.0288	f
Vanadium	5/5	1	0.053	0.006	0.046-0.060	f
Zinc	6/6	1	0.339	0.184	0.141-0.563	f

[a]The sample numbers used in this data set include: 99355, 99709, 99773, 99801, 99810, 99830, 99845, and 99860.
[b]Rejected data not included in total number of samples.
[c]Values qualified with an R, U, or UJ are excluded. The mean and standard deviation have been rounded to show no more than three significant figures. The range has been rounded to the nearest thousandth, unless a fourth decimal place is required to show a value.
[d]Values expressed in milligrams per liter (mg/L).
[e]Data obtained from 40 CFR 261.24.
[f]No standard MAC specified in 40 CFR 261.24.

000123

TABLE A.1-10

SUMMARY OF TCLP ORGANICS ANALYSES FOR SILO 2 RESIDUES - 1990/1991

Analyte[a]	Frequency of Detection[b]	Rejected	Mean[c] (mg/L)[d]	Standard Deviation[c] (mg/L)[d]	Range[c] (mg/L)[d]	Maximum Allowable Concentration[f] (mg/L)
PCBs and Pesticides						
alpha-BHC	1/6	1	0.0002	e	e	g
beta-BHC	3/6	1	0.0004	0.0002	0.0002-0.0006	g
Semivolatile Organics						
N-Nitroso-di-n-propylamine	1/7	0	0.005	e	e	g
Pentachlorophenol	1/7	0	0.018	e	e	100.0
Tributyl Phosphate	1/1	0	0.66	e	e	g
Volatile Organics						
2-Butanone	3/7	1	0.002	0.002	0.002-0.002	200.0
4-Methyl-2-pentanone	1/8	0	0.001	e	e	g
Acetone	2/8	0	0.0535	0.054	0.015-0.092	g
Carbon disulfide	1/8	0	0.004	e	e	g
Methylene chloride	2/8	0	0.03	0.023	0.014-0.046	g

[a]The sample numbers used in this data set include: 99707, 99708, 99772, 99780, 99800, 99804, 99809, 99817, 99829, 99836, 99844, 99852, 99859, and 99863.
[b]Rejected data not included in total number of samples.
[c]Values qualified with an R, U, or UJ are excluded. The mean and standard deviation have been rounded to show no more than three significant figures. The range has been rounded to the nearest thousandth, unless a fourth decimal place is required to show a value.
[d]Values expressed in milligrams per liter (mg/L).
[e]Analyte was detected in a single sample.
[f]Data obtained from 40 CFR 261.24.
[g]No standard MAC specified in 40 CFR 261.24.

TABLE A.1-11

ESTIMATED INVENTORY OF K-65 SILOS METALS

	Silo 1[a]		Silo 2[b]	
Analyte	Mean Inventory[c] (MT)[d]	UCL Inventory[c] (MT)[d]	Mean Inventory[c] (MT)[d]	UCL Inventory[c] (MT)[d]
Aluminum	7.06	8.88	4.92	6.46
Antimony	0.14	0.17	0.16	0.27
Arsenic	0.15	0.37	2.52	9.02
Barium	78.0	95.5	40.6	116
Beryllium	0.007	0.007	0.01	0.02
Boron	0.31	0.35	0.22	0.30
Cadmium	0.013	0.027	0.029	0.04
Calcium	19.9	24.5	194	1750
Chromium	0.28	0.37	0.23	0.30
Cobalt	6.29	7.40	5.73	14.1
Copper	1.92	2.23	3.09	4.76
Cyanide	0.013	0.020	0.02	0.03
Iron	98.8	142	96.1	168
Lead	549	642	281	1740
Magnesium	19.4	22.7	22.1	37.3
Manganese	0.48	0.65	0.95	1.51
Mecury	0.004	0.006	0.005	0.007
Molybdenum	32.6	42.3	1.69	2.56
Nickel	12.0	15.4	8.03	10.0
Potassium	2.88	3.31	1.26	1.96
Selenium	1.92	2.29	0.64	0.72
Silicon	4.86	5.74	4.95	6.68
Silver	0.07	0.09	0.10	0.13
Sodium	58.3	71.9	14.1	18.6
Thallium	0.002	0.009	0.006	0.012
Vanadium	0.91	1.08	1.38	1.73
Zinc	0.17	0.25	0.31	0.53

[a]Based on a volume of 3280 m^3 and a dry mass density of 2.050 gm/cm^3.
[b]Based on a volume of 2840 m^3 and a dry mass density of 2.050 gm/cm^3.
[c]Values for mean and UCI concentrations taken from Table 4-4 of the RI Report for OU4.
[d]Units are in metric tons (MT).

TABLE A.2-1

CONCENTRATIONS IN SILO 3 RESIDUES

Analyte [a]	Frequency of Detection[b]	Rejected	Arithmetic Mean[c] (pCi/g)[d]	Upper 95% CI on Mean[c] (pCi/g)[d]	Range of Detection[c] (pCi/g)[d]
SILO 3					
Actinium-227	9/9	2	618	925	234-1363
Lead-210	11/11	0	2620	3480	454-6427
Protactinium-231	9/11	0	487	627	266-931
Radium-224	11/11	0	290	367	64-453
Radium-226	11/11	0	2970	3870	467-6435
Radium-228	9/11	0	297	406	82-559
Thorium-228	7/11	0	590	747	459-996
Thorium-230	11/11	0	51200	60200	21010-71650
Thorium-232	8/11	0	656	842	411-1451
Uranium-234	11/11	0	1480	1730	348-1935
Uranium-235/236	10/11	0	93.6	117	42-158
Uranium-238	11/11	0	1500	1780	320-2043

[a]Sample numbers used in this data set include: 100097 - 100107.
[b]Rejected data not included in total number of samples.
[c]Values qualified with an R are excluded. The mean and upper 95% CI on mean have been rounded to show three significant figures. The mean is calculated using one-half the SQL for nondetects.
[d]Values expressed in picoCuries per gram (pCi/g).

000126

TABLE A.2-2

INVENTORY OF SILO 3 RADIOLOGICAL CONSTITUENTS

	Silo 3[a]	
Analyte	Mean Inventory[b] (Ci)[c]	UCL Inventory[b] (Ci)[c]
Actinium-227	5.4	8.2
Protactinium-231	4.3	5.5
Lead-210	23.2	30.8
Radium-224	2.6	3.2
Radium-226	26.3	34.2
Radium-228	2.6	3.6
Thorium-228	5.2	6.60
Thorium-230	453	532
Thorium-232	5.8	7.4
Uranium-234	13.1	15.3
Uranium-235/236	0.83	1.04
Uranium-238	13.3	15.7
Total Uranium[c]	39.9[d]	47.2[d]

[a]Based on a volume of 3900 m^3 and a dry mass density of 2.267 gm/cm^3.
[b]Values for mean and UCI concentrations taken from Table 4-19 of the RI Report for OU4.
[c]Values expressed in Curies.
[d]Total uranium mass values in MT. Calculated from isotopic distribution of uranium.

TABLE A.2-3

SUMMARY OF INORGANIC ANALYSES FOR SILO 3 RESIDUES

Analyte[a]	Frequency of Detection[b]	Rejected	Arithmetic Mean[c] (mg/kg)[d]	Upper 95% CI on Mean[c] (mg/kg)[d]	Range of Detection[c] (mg/kg)[d]
Metals					
Aluminum	11/11	0	17200	19800	10800-23700
Antimony	1/1	10	5.5[e]	e	e
Arsenic	11/11	0	1950	3170	532-6380
Barium	11/11	0	217	278	118-332
Beryllium	11/11	0	24.2	29.1	10-39.9
Cadmium	11/11	0	60	94	21.5-204
Calcium	11/11	0	29400	33400	21300-39900
Chromium	11/11	0	288	395	139-560
Cobalt	10/10	1	2100	2890	1100-3520
Copper	11/11	0	2550	3340	1610-7060
Iron	11/11	0	37800	52200	13900-67600
Lead	11/11	0	1730	2380	646-4430
Magnesium	11/11	0	58600	68900	38200-80900
Manganese	11/11	0	4380	5160	2420-6500
Mercury	3/3	8	0.4	0.7	0.3-0.69
Nickel	10/10	1	3150	4290	1760-6170
Potassium	11/11	0	7260	14000	1300-22800
Selenium	11/11	0	174	229	101-349
Silver	11/11	0	16	18	9.2-23.8
Sodium	11/11	0	36100	40800	22900-51700
Thallium	10/10	1	21	56	4-73.9
Vanadium	11/11	0	1820	3490	418-4550
Zinc	11/11	0	450	535	301-672

[a]Sample numbers used in this data set include: 100097 through 100107.
[b]Rejected data not included in total number of samples.
[c]Values qualified with an R are excluded. The mean and upper 95% CI on mean has been rounded to show three significant figures.
[d]Values expressed in milligrams per kilogram (mg/kg).
[e]Analyte detected in a single sample.

TABLE A.2-4

INVENTORY OF SILO 3 METALS

	Silo 3[a]	
Analyte	Mean Inventory[b] (MT)[c]	UCL Inventory[b] (MT)[c]
Aluminum	152	175
Arsenic	17.2	28.0
Barium	1.92	2.46
Beryllium	0.21	0.26
Cadmium	0.53	0.83
Calcium	260	295
Chromium	2.55	3.49
Cobalt	18.6	25.6
Copper	22.5	29.5
Iron	334	462
Lead	15.3	21.0
Magnesium	518	609
Manganese	38.7	45.6
Mercury	0.004	0.006
Nickel	27.9	37.9
Potassium	64.2	124
Selenium	1.54	2.02
Silver	0.14	0.16
Sodium	319	361
Thallium	0.19	0.50
Vanadium	16.1	30.9
Zinc	3.98	4.73

[a]Based on a volume of 3900 cubic meters (m^3) and a dry mass density of 2.267 gm/cm^3.
[b]Values for mean and UCI concentrations taken from Table 4-20 of the RI Report for OU4.
[c]Units are expressed in metric tons (MT).

TABLE A.2-5

EP TOXICITY RESULTS FOR SILO 3 RESIDUES - 1989[a]

Analyte[b]	Frequency of Detection	Mean (mg/L)[d]	Standard Deviation (mg/L)[d]	Minimum (mg/L)[d]	Maximum (mg/L)[d]	Maximum Allowable Concentration[c] (mg/L)[d]
Silo 3						
Arsenic	9/11	9.481	12.393	ND[e]	41.5	5.0
Barium	11/11	0.080	0.046	0.02	0.156	100.0
Cadmium	11/11	0.847	1.740	0.108	6.32	1.0
Chromium	11/11	5.05	3.22	0.336	11.9	5.0
Lead	7/11	0.239	0.327	ND[e]	1.01	5.0
Mercury	2/11	0.0005	0.0009	ND[e]	0.003	0.2
Selenium	11/11	2.65	3.00	0.92	11.7	1.0
Silver	1/11	0.007	0.008	ND[e]	0.032	5.0

[a]The data presented in table have not been validated.
[b]The sample numbers used in this data set include: MM3325 through MM3335.
[c]Data obtained from 40 CFR 261.24.
[d]Values expressed in milligrams per liter (mg/L).
[e]ND - Not Detected.

TABLE A.2-6

TCLP RADIOLOGICAL ANALYSES FOR SILO 3 RESIDUES

Radiological Parameters[a]	Concentration (pCi/L)[b]
Actinium-227	5.54 ± 1.94
Gross alpha	3150 ± 830
Gross beta	670 ± 340
Lead-210	87.1 ± 9.2
Polonium-210	245 ± 110
Protactinium-231	< 647
Radium-226	2455 ± 558
Radium-228	< 110
Thorium-228	3.17 ± 1.42
Thorium-230	10.4 ± 2.8
Thorium-232	< 1
Uranium-234	92.2 ± 13.8
Uranium-235/236	5.09 ± 1.59
Uranium-238	86 ± 13

[a]Data from sample 100074 (11/12/92).
[b]Values for concentration taken from Table 4-22 of the RI Report for OU4, expressed in picoCuries per liter (pCi/L).

TABLE A.2-7

SUMMARY OF SUBSURFACE SOIL RADIOLOGICAL ANALYSES

Analyte[a]	Frequency of Detection[b]	Rejected	Mean[c] (pCi/g)[d]	Standard Deviation[c] (pCi/g)[d]	Range[c] (pCi/g)[d]
Radium-226	15/23	3	0.80	0.27	0.53-1.5
Radium-228	8/23	3	0.66	0.26	0.41-1.1
Strontium-90	4/19	8	1.18	1.09	0.5-2.8
Technetium-99	2/26	0	2.85	1.06	2.1-3.6
Thorium-228	12/26	0	0.850	0.206	0.631-1.3
Thorium-230	23/26	0	1.46	0.963	0.716-4.8
Thorium-232	6/26	0	0.808	0.262	0.6-1.3
Total Thorium	23/23	0	5.04[e]	3.50[e]	1.3-15[e]
Total Uranium	19/21	4	6.60[e]	7.92[e]	1.64-37.1[e]
Uranium-234	20/26	0	1.24	0.760	0.6-3.4
Uranium-238	23/26	0	1.79	2.98	0.6-15

[a]The sample numbers used in this data set include: 7407, 7504, 8188, 8272, 8279, 8854, 32456, 32465, 32766, 32773, 33083, 33090, 55998 through 56004, 56013 through 56021, 56023, 56025, and 56029.
[b]Rejected data not included in total number of samples.
[c]Values qualified with a R or < are excluded. The mean and standard deviation have been rounded to show no more than three significant figures.
[d]Values expressed in picoCuries per gram (pCi/g).
[e]Values expressed in micrograms per gram (μg/g).

APPENDIX B

DOE Letter (DOE-0817-93), April 16,1993, T.J. Rowland to N.C. Kaufman, **REMOVAL SITE EVALUATION, APPLICABILITY TO OPERABLE UNIT 4 PILOT PLANT**

5838

Department of Energy

Fernald Environmental Management Project
P.O. Box 398705
Cincinnati, Ohio 45239-8705
(513) 738-6367

APR 1 6 1993

DOE-0817-93

Mr. N. C. Kaufman, President
Fernald Environmental Restoration
Management Corporation
P. O. Box 398704
Cincinnati, OH 45239-8704

Dear Mr. Kaufman:

REMOVAL SITE EVALUATION, APPLICABILITY TO OPERABLE UNIT 4 PILOT PLANT

The Department of Energy, Fernald Field Office concurs with the enclosed Fernald Environmental Restoration Management Corporation position which states that a Removal Site Evaluation is not required for the Operable Unit 4 pilot plant project.

If you or your staff have any questions, please contact Randi Allen at FTS/Commercial 513-748-6158.

Sincerely,

Ray Hansen
for Thomas J. Rowland
Acting Manager

FN:Allen

Enclosure: As Stated

cc w/enc.:

W. Pickles, FERMCO/52-4
R. Frost, FERMCO/52-4

Fernald Environmental

FERMCO

Restoration Management Corporation P.O. Box 398704 Cincinnati, Ohio 45239-8704 (513) 738-6200

December 22, 1992

U. S. Department of Energy
Fernald Environmental Management Project
Letter No. C:OP:92-067

Mr. James J. Fiore, Acting Manager
DOE Field Office, Fernald
P. O. Box 398705
Cincinnati, Ohio 45239-8705

Dear Mr. Fiore:

CONTRACT DE-AC05-920R21972, RSE APPLICABILITY TO CRU4 PILOT PLANT ACTIVITIES

As part of final remediation for Silos 1, 2, and 3, CRU4 is constructing a Pilot Plant for demonstration of vitrification capability for Silo 3 and K-65 type material. Existing site Regulatory Compliance Guide (RCG) M-1, dated November 7, 1990, requires the preparation of a Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) Removal Site Evaluation (RSE) for all site excavation activities that involve over 1 yd^3 of soil in areas with above background concentrations of hazardous substances, including radionuclides.

The purpose of this letter is to transmit for your concurrence the CRU4 position regarding the applicability of this guidance to planned Pilot Plant construction activities. Since the Pilot Plant will not be constructed over an abandoned site, but will be a part of the RI/FS treatability studies to support final remediation of the Silo contents, CRU4 does not believe an RSE is warranted or required to meet the intent of the National Contingency Plan. CRU4 desires to proceed with the Pilot Plant project as scheduled, while minimizing the procedural and regulatory complexity and paperwork associated with site requirements of limited or outdated applicability. CRU4 intends to comply with all legal requirements applicable to CRU4, and meet the ARARs and substantive requirements of 40 CFR 300.410 for an RSE using existing, approved site procedures. This approach will be outlined in the project workplan.

FERMCO
Restoration Management Corporation

5838

The Pilot Plant will be used initially to demonstrate the technology and process on an inert material (sand) and then be modified to perform treatability studies on the K-65 material. CRU4 is proceeding on the basis that an RSE is not required for the initial phase, but will probably be required for the second phase testing.

Our construction schedule requires site preparation activities to begin no later than March 1993. Since preparation and approval of an RSE, if required, takes several weeks to complete, it is critical to receive the concurrence of DOE-FN on our proposed direction no later than the first week in January. Please let me know if we need to meet to further discuss this approach. Our point of contact is Robert Frost (X 8941).

Very truly yours,

N. C. Kaufman
President

NCK:RHF:slk

Attachment

cc: R. B. Allen, DOE-FN
J. R. Craig, DOE-FN
D. P. Dubois
R. Mendelsohn, DOE Contract Specialist
D. Paine
W. S. Pickles
W. Quaider, DOE-FN
M. J. Strimbu
J. W. Theising

Central Files
DW:92-0477.1

APPENDIX C

Potential ARARs and TBC Criteria for the Phase II OU4 Pilot Plant Program

APPENDIX C

Potential Applicable or Relevant and Appropriate Requirements (ARARs), and To Be Considered (TBC) Criteria for the Phase II OU4 Pilot Plant Program

<table>
<tr><th>Chemical, Location, or Action</th><th>Requirement</th><th>ARAR/TBC</th><th>Strategy for Compliance</th></tr>
<tr>
<td>Ohio Water Quality Standards</td>
<td>3745-1-07

Use Designations and Criteria

All pollutants or combinations of pollutants shall not exceed, outside the mixing zone, the Numerical and Narrative Criteria for Aquatic Life Habitat and Water Supply Use Designations listed in Tables 7-1 through 7-15 of this rule.

The following constituents of concern (COCs) for Operable Unit 4 have warm water habitat maximum concentration levels outside the mixing zone as follows:

<table>
<tr><th>Constituent</th><th>Criteria conc.[a] (ug/L)</th><th>30-day average conc. (ug/L)</th></tr>
<tr><td>Antimony</td><td>650</td><td>190</td></tr>
<tr><td>Arsenic</td><td>360</td><td>190</td></tr>
<tr><td>Beryllium</td><td>Tab. 7-10[b]</td><td>Tab. 7-11[c]</td></tr>
<tr><td>Cadmium</td><td>Tab. 7-10</td><td>Tab. 7-11</td></tr>
<tr><td>Chromium</td><td>Tab. 7-10</td><td>Tab. 7-11</td></tr>
<tr><td>Copper</td><td>Tab. 7-10</td><td>Tab. 7-11</td></tr>
<tr><td>Cyanide</td><td>46</td><td>12</td></tr>
<tr><td>Lead</td><td>Tab. 7-10</td><td>Tab. 7-11</td></tr>
<tr><td>Mercury</td><td>1.1</td><td>0.20</td></tr>
<tr><td>Nickel</td><td>Tab. 7-10</td><td>Tab. 7-11</td></tr>
<tr><td>Selenium</td><td>20</td><td>5.0</td></tr>
<tr><td>Silver</td><td>Tab. 7-10</td><td>1.3</td></tr>
<tr><td>Thallium</td><td>71</td><td>16</td></tr>
<tr><td>Zinc</td><td>Tab. 7-10</td><td>Tab. 7-11</td></tr>
<tr><td>2-Butanone</td><td>160,000</td><td>7,100</td></tr>
<tr><td>4-Nitrophenol</td><td>790</td><td>35</td></tr>
<tr><td>Acetone</td><td>550,000</td><td>78,000</td></tr>
<tr><td>Aldrin</td><td>----</td><td>0.01</td></tr>
<tr><td>Bis(2-ethylhexyl)phthalate</td><td>1,100</td><td>8.4</td></tr>
<tr><td>Carbon tetrachloride</td><td>1,800</td><td>280</td></tr>
</table>

(CONTINUED ON NEXT PAGE)</td>
<td>Applicable</td>
<td>Paddys Run and the stream segment of the Great Miami River adjacent to the FEMP are designated as warm water aquatic life habitats with use designations of agricultural and industrial water supply, and primary contact recreation. OAC 3745-1-21 establishes the classification of the receiving waters for the FEMP. Wastewater generated at the Pilot Plant will be pretreated (if required) and discharged to the existing FEMP wastewater treatment system and Advanced Wastewater Treatment System (AWWT) prior to discharge to the Great Miami River. Treatment will be in accordance with FEMP NPDES permit limits and conditions or applicable Water Quality Standards.

Stormwater discharges associated with the construction and operation of the Pilot Plant will be managed in accordance with 40 CFR 122.26 and OAC 3745-38. Existing site protocols and procedures related to stormwater management will be extended to the construction and operation of this facility.</td>
</tr>
</table>

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Chemical, Location, or Action	Requirement			ARAR/TBC	Strategy for Compliance
Ohio Water Quality Standards (cont.)	DDT	----	0.001		
	Dieldrin	----	0.005		
	Di-n-butylphthalate	350	190		
	Diethylphthalate	2,600	120		
	Dimethylphthalate	1,700	73		
	Endosulfan[d]	----	0.003		
	Endrin	----	0.002		
	Fluoranthene	200	8.9		
	Methylene chloride	9,700	430		
	PCBs	----	0.001		
	Phenol	5,300	370		
	Tetrachloroethene	540	73		
	Toluene	2,400	1,700		

[a] Criteria concentration shall be met outside mixing zone.

[b] Criteria concentration based on hardness of water. See Table 7-10 for calculation to determine maximum concentration outside the mixing zone.

[c] 30-day average criteria based on hardness of water. See Table 7-11 for calculation to determine allowable 30-day average concentration outside the mixing zone.

[d] No designation was made as to whether endosulfan referred to endosulfan I or endosulfan II or the sum total of both.

The remaining COCs for OU4 will have criteria concentration levels based on calculated acute aquatic criteria (AAC) or chronic aquatic criteria (CAC).

000139

Chemical, Location, or Action	Requirement	ARAR/TBC	Strategy for Compliance
Radionuclide Emissions (Except Airborne Radon-222)	40 CFR 61, Subpart H Emissions of radionuclides to the ambient air from DOE facilities shall not exceed those amounts that will cause any member of the public to receive in any year an effective dose equivalent of 10 mrem per year. Monitoring is required at all release points which have a potential to discharge radionuclides into the air in quantities which could cause an effective dose equivalent in excess of 1% (0.1 mrem/yr) of the standard .	Applicable	The pollution control equipment for the silos and vitrification off-gas emissions will be designed to limit the discharge of radionuclides to acceptable levels. The facility design will include HEPA filters to minimize particulate emissions. Excavations, excavated soil and other sources of particulate emissions will be controlled, as appropriate, through good construction practices. Monitoring of radionuclide emissions will be conducted in accordance with the methods referenced in 40 CFR 61.93 with compliance being demonstrated using an EPA approved computer code.
Radon-222 Emissions	40 CFR 61, Subpart Q No source at a DOE facility shall emit more than 20 pCi/m^2-s of radon-222 as an average for the entire source during periods of storage and disposal.	Applicable	While this requirement is neither applicable nor relevant and appropriate to treatment operations, it is applicable to storage of waste material in Silos 1 and 2 prior to treatment, and storage of vitrified product following treatment. Design of the waste removal system, along with appropriate procedures, controls, and monitoring, will minimize radon releases during the material removal phase. Design and operation of the vitrified product storage area will address this requirement, along with appropriate controls, procedures and monitoring systems.

000140

Chemical, Location, or Action	Requirement	ARAR/TBC	Strategy for Compliance
Discharge of Storm Water Runoff	40 CFR 122.26 and OAC 3745-38 Storm water discharge associated with construction sites and industrial activities must be monitored and controlled. A Stormwater Pollution Prevention Plan (SWPPP) is required for construction activities which result in a total land disturbance of 5 or more acres.	Applicable	Industrial stormwater discharges associated with the Pilot Plant are covered by the FEMP NPDES Stormwater Permit Application submitted to OEPA in September, 1992. A sitewide Stormwater Pollution Prevention Plan (SWPPP) is being prepared pursuant to this application. Construction associated with the Pilot Plant will utilize appropriate controls to ensure contamination of stormwater is minimized. Outside pads (not under roof) will have berms or curbs to contain runoff, and to prevent run on. Collected stormwater will be discharged through the existing site wastewater treatment system.
Discharge of Treatment System Effluent	40 CFR 125.100 <u>Best Management Practices</u> Develop and implement a Best Management Practices (BMP) program to prevent the release of toxic or hazardous constituents to waters of the U.S. Development and implementation of a sitewide BMP program is also required as a condition of the FEMP NPDES Permit. 40 CFR 125.104 The BMP program must: • Establish specific procedures for the control of toxic and hazardous pollutant spills and runoff. • Include a prediction of direction, rate of flow, and total quantity of toxic and hazardous pollutants where experience indicates a reasonable potential for equipment failure.	Relevant and Appropriate	The proposed action has the potential for releases and runoff from this operable unit. The requirement will be met by following the conditions of the sitewide Best Management Practices (BMP) program, as described in the approved BMP Plan. The design and operating procedures will be modified as necessary to ensure controls are in place that prevent contamination of receiving waters and that provide treatment of wastewaters prior to discharge.

000141

Chemical, Location, or Action	Requirement	ARAR/TBC	Strategy for Compliance
Ohio Water Quality Standard	OAC 3745-1-04 The following general water quality criteria apply to both discharges to surface waters as a result of remediation and on-site surface waters potentially affected by project activities. All surface waters of the state shall be free from: • objectionable suspended solids • floating debris, oil and scum • materials that create a nuisance • toxic, harmful or lethal substances • nutrients that create nuisance growth	Relevant and Appropriate	Wastewater produced at the Pilot Plant will be pretreated, if necessary, and discharged to the FEMP wastewater treatment system to comply with these aquatic quality criteria. Compliance with stormwater requirements, BMPs, and contingency plan will ensure compliance with this requirement.
Compliance with Floodplain/Wetlands Environmental Review Requirements	10 CFR 1022 (Executive Order 11990) DOE actions in a floodplain or wetland must first evaluate the potential adverse effects those actions might have on the floodplain or wetland, and consider the natural and beneficial values served by the wetlands.	Applicable	The proposed action has the potential to destroy or modify site wetland areas. Potential impacts are identified during preparation of NEPA documentation for this activity. NEPA documentation will also specify public notice requirements, wetland assessments, and any mitigative measures that may be required.

000142

<table>
<tr><th>Chemical, Location, or Action</th><th>Requirement</th><th>ARAR/TBC</th><th>Strategy for Compliance</th></tr>
<tr>
<td>Radiation Protection of the Public and the Environment</td>
<td>
DOE Order 5400.5 Chap. III

Residual concentrations of radionuclides in air in uncontrolled areas are limited to the following. (For known mixtures of radionuclides, the sum of the ratios of the observed concentration of each radionuclide to its corresponding limit must not exceed 1.0.)

Derived Concentration Guide[a]
(uCi/mL)

<table>
<tr><th>Isotope</th><th>D</th><th>W</th><th>Y</th></tr>
<tr><td>Actinium-227</td><td>2×10^{-15}</td><td>7×10^{-15}</td><td>1×10^{-14}</td></tr>
<tr><td>Lead-210</td><td>9×10^{-13}</td><td>——[b]</td><td>——</td></tr>
<tr><td>Polonium-210</td><td>1×10^{-12}</td><td>1×10^{-12}</td><td>——</td></tr>
<tr><td>Protactinium-231</td><td>——</td><td>9×10^{-15}</td><td>1×10^{-14}</td></tr>
<tr><td>Radium-224</td><td>——</td><td>4×10^{-12}</td><td>——</td></tr>
<tr><td>Radium-226</td><td>——</td><td>1×10^{-12}</td><td>——</td></tr>
<tr><td>Radium-228</td><td>——</td><td>3×10^{-12}</td><td>——</td></tr>
<tr><td>Radon-222</td><td>3×10^{-9}</td><td>3×10^{-9}</td><td>3×10^{-9}</td></tr>
<tr><td>Technetium-99</td><td>1×10^{-8}</td><td>2×10^{-9}</td><td>——</td></tr>
<tr><td>Strontium-90[c]</td><td>5×10^{-11}</td><td>——</td><td>9×10^{-12}</td></tr>
<tr><td>Thorium-228</td><td>——</td><td>5×10^{-14}</td><td>4×10^{-14}</td></tr>
<tr><td>Thorium-230</td><td>——</td><td>4×10^{-14}</td><td>5×10^{-14}</td></tr>
<tr><td>Thorium-232</td><td>——</td><td>7×10^{-15}</td><td>1×10^{-14}</td></tr>
<tr><td>Uranium-234</td><td>4×10^{-12}</td><td>2×10^{-12}</td><td>9×10^{-14}</td></tr>
<tr><td>Uranium-235</td><td>5×10^{-12}</td><td>2×10^{-12}</td><td>1×10^{-13}</td></tr>
<tr><td>Uranium-236</td><td>5×10^{-12}</td><td>2×10^{-12}</td><td>1×10^{-13}</td></tr>
<tr><td>Uranium-238</td><td>5×10^{-12}</td><td>2×10^{-12}</td><td>1×10^{-14}</td></tr>
</table>

[a] D, W, and Y (Days, Weeks, and Years) represent lung retention classes; removal halftimes assigned to the compounds with classes D, W, and Y are 0.5, 50, and 500 days, respectively. Exposure conditions assume an inhalation rate of 8,400 m^3 of air per year (based on an exposure over 24 hours per day, 365 days per year).

[b] A hyphen means no limit has been established.

[c] The value shown for daily DCG is for strontium radionuclides with a f_1 value of 3×10^{-1}. The value shown for yearly DCG is for strontium radionuclides for a f_1 value of 1×10^{-2}.
</td>
<td>To Be Considered</td>
<td>Operation of the OU4 Pilot Plant has the potential to release radionuclides that are contained in the waste materials. The facility design will include HEPA filtration to control radionuclide and particulate emissions where appropriate. Excavations, excavated soil and other sources of particulate emissions will be controlled, as appropriate, through established construction practices. Monitoring of radionuclide emissions will be conducted in accordance with the methods referenced in 40 CFR 61.93 with compliance being demonstrated using an EPA approved computer code.</td>
</tr>
</table>

000143

Chemical, Location, or Action	Requirement	ARAR/TBC	Strategy for Compliance
Radiation Protection of the Public and the Environment	DOE Order 5400.5 Chapter III Residual concentrations of radionuclides in water that may be ingested are listed below. These derived concentration guides (DCGs) for the COCs are based on a committed effective dose equivalent (CEDE) of 100 mrem/yr, assuming ingestion of 2 liters/day. Note that these DCGs apply <u>only if</u> ingestion is the single pathway of exposure. Isotope — Ingested Water (uCi/mL) Actinium-227 — 1×10^{-8} Lead-210 — 3×10^{-8} Polonium-210 — 8×10^{-8} Protactinium-231 — 1×10^{-8} Radium-224 — 4×10^{-7} Radium-226 — 1×10^{-7} Radium-228 — 1×10^{-7} Technetium-99 — 1×10^{-4} Strontium-90[c] — 1×10^{-6} Thorium-228 — 4×10^{-7} Thorium-230 — 3×10^{-7} Thorium-232 — 5×10^{-8} Uranium-234 — 5×10^{-7} Uranium-235 — 6×10^{-7} Uranium-236 — 5×10^{-7} Uranium-238 — 6×10^{-7}	To Be Considered	Remediation of OU4 waste has the potential to release radionuclides that are contained in the waste materials to environmental media. Although activities anticipated by this project will take place over the Great Miami aquifer, which is used as a source of drinking water, no release of radionuclides to soil or groundwater is expected to occur as a result of Pilot Plant activities. Wastewater generated at the Pilot Plant will be pretreated and discharged to the existing FEMP wastewater treatment system. Treatment will ensure that the discharges do not violate FEMP NPDES permit limits and conditions or applicable Water Quality Standards.

000144

Chemical, Location, or Action	Requirement	ARAR/TBC	Strategy for Compliance
Residual Radioactive Material	DOE Order 5400.5 Chap. IV, 6.b Interim Storage: The above-background concentration of radon-222 in air above an interim storage facility must not exceed 100 pCi/L at any point, an annual average of 30 pCi/L over the facility, or an annual average of 3 pCi/L at or above any location outside the site.	To Be Considered	Management of radium bearing waste might result in the release of radon gas to the environment. Removal of radium bearing waste and storage prior to vitrification will include controls designed to prevent untreated release of radon. During operation of the Pilot Plant, the facility off-gas system design (activated carbon beds followed by HEPA filters) will provide adequate radon controls. These requirements will be met for interim storage of the vitrified product due to the low surface release rate of radon gas. Radon monitoring will be conducted outside the storage area to demonstrate compliance with these release limits.

000145

Chemical, Location, or Action	Requirement	ARAR/TBC	Strategy for Compliance
Hazardous Waste Determinations	40 CFR 262.11 OAC 3745-52-11 Any generator, who treats, stores, or disposes of solid wastes, must determine whether or not the waste is hazardous. The procedures to be followed include: • To identify whether a particular material of concern is a "solid waste" • To identify whether a particular exclusion applies to the material eliminating it from definition as a "solid waste" • To identify whether a particular solid waste might be classified as a hazardous waste • To determine if a material, otherwise classified as a "hazardous waste" might be excluded from RCRA regulation	Relevant and Appropriate (This requirement will be applicable to non-excluded solid wastes).	These procedures are established to determine whether wastes are subject to the requirements of RCRA. The residues in Silos 1, 2, and 3 are specifically exempt from the applicability of RCRA requirements. However, these procedures are relevant and appropriate to determine whether OU4 wastes, whether excluded or not, are similar to hazardous wastes based on the TCLP results. To ensure protectiveness, wastes sufficiently similar to hazardous waste will be treated, stored, and disposed in accordance with RCRA requirements. Other wastes, such as those generated during construction and operation of the Pilot Plant, will also require testing or process knowledge to determine proper management and disposal requirements. Characterization of waste generated during construction projects, including soil, will be performed in accordance with site procedure SSOP-0044. All other waste characterization will be performed in accordance with site procedure SSOP-0002.

000146

5083

Chemical, Location, or Action	Requirement	ARAR/TBC	Strategy for Compliance
Empty Containers	40 CFR 261.7 OAC 3745-51-07 Containers that have held hazardous wastes are "empty" and exempt from further RCRA regulations if: • no more than 2.5 cm (one inch) of residue remains on bottom of inner liner; or • the remaining residue is less than 3% by weight of the total capacity, for containers whose total capacity is less than or equal to 110 gallons, or • the remaining residue is less than 0.3% by weight of the total capacity, for containers whose total capacity is greater than 110 gallons.	Relevant and Appropriate	Containers and tanks used to store waste or the treated contents of Silos 1, 2, and 3 might contain residues that exhibit hazardous waste characteristics which must be removed before the container might be reused or disposed. Removed material, if sufficiently similar to hazardous waste, will be managed in accordance with appropriate regulatory requirements.

000147

Chemical, Location, or Action	Requirement	ARAR/TBC	Strategy for Compliance
Treatment, Storage, or Disposal Facility Standards	40 CFR 264, Subpart B, General Standards OAC 3745-54-13 through 16 1) Waste Analysis (OAC 3745-54-13)-Operators of a facility must obtain a detailed chemical and physical analysis of a representative sample of each hazardous waste to be treated, stored, or disposed of at the facility prior to treatment, storage, or disposal. 2) Security (OAC 3745-54-14)-Operators of a facility must prevent the unknowing or unauthorized entry of persons or livestock into the active portions of the facility, maintain a 24-hour surveillance system, or surround the facility with a controlled access barrier and maintain appropriate warning signs at facility approaches. 3) Inspections (OAC 3745-54-15)-Operators of a facility must develop a schedule and regularly inspect monitoring equipment, safety and emergency equipment, security devices and operating and structural equipment that are important to preventing, detecting or responding to environmental or human health hazards, promptly or immediately or immediately remedy defects, and maintain an inspection log. 4) Training (OAC 3745-54-16)-Operators must train personnel within 6 months of their assumption of duties at a facility in hazardous waste management procedures relevant to their position including emergency response training.	Relevant and Appropriate	Areas and activities of this project which could contain or generate hazardous waste or waste sufficiently similar to RCRA hazardous waste must comply with these RCRA requirements. 1) An OU4 Pilot Plant sampling and analysis plan will be developed. Compliance will be met by following site procedures SSOP-0044 (construction debris and soils) and SSOP-0002 (other wastes). Silo waste material has already been characterized in accordance with this requirement. 2) Existing site security measures and physical barriers around the silos and the FEMP complex are sufficient to satisfy these requirements. 3) Scheduling for inspection and monitoring of safety and emergency equipment specifically related to the Pilot Plant will be presented in the SOPs that are generated for operation of the facility. 4) All operations personnel will be trained in accordance with existing FEMP requirements. Additional training will be required for the specific job related requirements associated with CRU4 Pilot Plant operations.

Chemical, Location, or Action	Requirement	ARAR/TBC	Strategy for Compliance
Treatment, Storage, or Disposal Facility Preparedness and Prevention	40 CFR 264, Subpart C OAC 3745-54-31 TSD operators must design, construct, maintain and operate facilities to minimize the possibility of a fire, explosion or any unplanned sudden or non-sudden release of hazardous waste to air, soil, or surface water which could threaten human health or the environment. OAC 3745-54-32 All facilities must be equipped with an internal communication or alarm system, a telephone, or a two-way radio for calling outside emergency assistance, fire control, spill control and decontamination equipment and water at an adequate volume and pressure to supply water hose streams, foam producing equipment, automatic sprinklers or water spray systems. OAC 3745-54-33 All fire and spill-control and decontamination equipment must be tested and maintained as necessary to assure proper emergency operation. OAC 3745-54-34 All personnel must have immediate access to emergency communication or alarm systems whenever hazardous waste is being handled at the facility. OAC 3745-54-35 Aisle space must be sufficient to allow unobstructed movement of personnel, fire and spill control, and decontamination equipment. OAC 3745-54-37 Operators must attempt to make arrangements, appropriate to the waste handled, for emergency response by local and state fire, police and medical personnel.	Relevant and Appropriate	The existing site-wide internal communications/alarm system will be modified as necessary to accomodate operation of the Pilot Plant facility. A fire sprinkler system will be included as part of the design of the Pilot Plant. In addition, portable fire extinguishers and spill control and decontamination equipment will be placed at accessible locations to assist in emergency response. The facility will be designed to include adequate aisle space. The site's Emergency Response Team will be available, with assistance from local and state personnel, for responding to emergency situations related to the Pilot Plant. In addition, site Emergency Response Team personnel will be trained to adequately respond to emergencies specifically related to the Pilot Plant.

000149

Chemical, Location, or Action	Requirement	ARAR/TBC	Strategy for Compliance
Treatment, Storage, or Disposal Facility Contingency Plan and Emergency Procedures	40 CFR 264, Subpart D 40 CFR 264.51 OAC 3745-54-51 Each facility operator must have a contingency plan designed to minimize hazards to human health or the environment due to fires, explosions, or any unplanned releases of hazardous waste constituents to the air, soil, or surface/groundwater. 40 CFR 264.52 OAC 3745-54-52 Contingency plans should address procedures to implement a response to hazardous waste incidents, and provide internal and external communications, arrangements with local emergency authorities, an emergency coordinator list, a facility emergency equipment list indicating equipment descriptions and locations, and a facility personnel evacuation plan. A copy must be maintained at the site as well as submitted to appropriate emergency agencies. 40 CFR 264.55 and .56 OAC 3745-54-55 & 56 Each facility must have an emergency coordinator who has responsibility for coordinating all emergency response measures, is on the premises or on call at all times, is thoroughly familiar with all aspects of the contingency plan, facility operations, location and characteristics of waste handled, location of pertinent records, and facility layout, and who has the authority to commit the resources necessary to implement the contingency plan in the event of an emergency.	Relevant and Appropriate	Specific procedures to respond to emergencies and unplanned events or releases associated with the Pilot Plant will be addressed in the project specific Health and Safety Plan. Existing site procedures, such as the FEMP Emergency Plan (PL-3020), Emergency Response Team Procedures Manual (ERT-001), Spill Incident Reporting and Cleanup (SSOP-0067), and Event Notification and Reporting (ED-0001) will be implemented as is appropriate for spills, fires, or other emergencies. In addition, procedures specific to operations at the K-65 silos, i.e., "K-65 Silo Numbers 1 and 2 Area Emergencies (SOP 65-C-201)" and "Radon Treatment System Emergencies (SOP 66-C-909)", will be revised and implemented as applicable to the new conditions.

Chemical, Location, or Action	Requirement	ARAR/TBC	Strategy for Compliance
Container Storage	40 CFR 264.171 - 178 Subpart I OAC 3745-55-71 through 78 1) Containers of RCRA hazardous waste must be: a) Maintained in good condition; b) Compatible with hazardous waste to be stored; and c) Closed during storage (except to add or remove waste) d) Managed in a manner that will not cause the container to rupture or leak 2) Storage areas must be inspected weekly for leaking and deteriorated containers and containment systems. 3) At closure, remove all hazardous waste and residue from the containment system, and decontaminate or remove all containers, liners, bases, and contaminated soils.	Relevant and Appropriate	Compliance with this requirement will be as follows: 1) Closed containers of vitrified product will be stored on-site in an approved storage facility. The containers will be compatible with the waste products. 2) Since the vitrified product will not contain free liquids, the storage area will be designed only to prevent run-on. Since the stored product will pose a significant radiation hazard, the frequency of inspection will be kept to a minimum in accordance with an SOP that addresses waste storage. The waste product storage area will be shielded to minimize the radiation hazard. 3) Closure of the storage area will not be included in the scope of this project. Closure of the area will be part of final remediation of the OU in which the storage facility is located. Vitrified waste product will no longer be "sufficiently similar" to hazardous waste since it will no longer exhibit a RCRA characteristic. Containers of other solid waste awaiting characterization, or material characterized as hazardous waste will be managed in accordance with Management of Soil, Debris, and Waste from a Project (SSOP-0044) and the FEMP Waste Management Plan.

000151

Chemical, Location, or Action	Requirement	ARAR/TBC	Strategy for Compliance
Tank Systems	40 CFR 264, Subpart J (Tanks) OAC 3745-55-91 through 96; and 3745-55-97(A) Design, operating, and inspection standards for tank units within which hazardous waste is stored or treated. • Tank design must be compatible with the material being stored. • Tank must be designed and have sufficient strength to store or treat waste to ensure it will not rupture or collapse. • Tank must have secondary containment that is capable of detecting and collecting releases to prevent migration of wastes or accumulated liquid to the environment. • At closure, remove all hazardous waste and residue from the containment system, and decontaminate or remove all tanks, liners, bases, and contaminated soils.	Relevant and Appropriate	All process tanks will be constructed with durable material that is compatible with the waste and treatment process for which the tank is designed. The facility design will include secondary containment capable of collecting releases. Approved inspection and maintenance procedures, which include scheduled visual inspections of all tanks, will be established prior to initiation of Pilot Plant operations. Closure at the end of the useful life of the tanks will be included in the final remediation of OU4.
Miscellaneous Units	40 CFR 264 Subpart X OAC 3745-57-91 and 92 Environmental performance standard, monitoring, inspection, and post-closure care for treatment in miscellaneous units as defined by 40 CFR 260.10. 40 CFR 264.601 OAC 3745-57-91 Locate, design, construct, operate, close, and maintain to protect human health and the environment and prevent releases to groundwater, subsurface water, surface water, wetlands, soil, and air. Permit terms shall use Subpart I through O, Part 270, and Part 146 requirements as appropriate. 40 CFR 264.602 OAC 3745-57-92 Monitoring, testing, analytical data, inspections, response, and reporting procedures must ensure compliance with 40 CFR 264.601, 264.15 (general inspection requirements), 264.33 (testing and maintenance of emergency equipment), and 264.77 (reports of releases, fires, explosions, and closures).	Relevant and Appropriate	A vitrification unit could be considered a miscellaneous unit. Although no permit is required for this activity, the design, construction, operation, and maintenance of the unit will be in accordance with other ARARs, DOE orders, and accepted construction standards and practices, as appropriate. Included in the design will be secondary containment and emission controls to ensure that releases to air or water are prevented, or meet stipulated requirements or limits. Monitoring and inspection activities will be conducted to ensure compliance with these requirements. Closure of this unit will be conducted under final remediation of the OU4 area.

000152

Chemical, Location, or Action	Requirement	ARAR/TBC	Strategy for Compliance
Containment Buildings	40 CFR 264, Subpart DD Hazardous waste and debris may be placed in units known as containment buildings, as defined in 40 CFR 260.10, for the purpose of interim storage or treatment. 40 CFR 264.1101 Containment buildings must be fully enclosed to prevent exposure to the elements and ensure containment of managed wastes. Floor and containment walls must be designed and constructed of materials of sufficient strength and thickness to support themselves, the waste contents, and any personnel and heavy equipment that operate within the unit. All surfaces coming in contact with hazardous waste must be chemically compatible with waste. Primary barriers must be constructed to prevent migration of hazardous constituents into barrier. Secondary containment systems including secondary barrier and leak detection system must also be constructed for containment buildings used to manage wastes containing free liquids. Controls must be implemented to ensure: the primary barrier is free of significant cracks, corrosion, or other deterioration that may allow release of hazardous waste; the level of hazardous waste does not exceed height of containment walls and is otherwise maintained within containment walls; tracking of waste out of unit by personnel or equipment used in handling waste is prevented; and fugitive dust emissions are controlled at level of no visible emissions.	Relevant and Appropriate	Containment buildings, as defined, are not land disposal units, so they can be used to store prohibited waste prior to treatment or disposal. During the operation of the Pilot Plant, waste materials might require temporary management for the purpose of staging or treating the material. Some of the waste material may be sufficiently similar to hazardous waste to make this requirement relevant and appropriate. Design, construction, operation, and maintenance of the buildings will be in accordance with this requirement, and other ARARs, DOE orders, and accepted construction standards and practices, as appropriate. Included in the design will be secondary containment devices (if free liquids are present) and emission controls to control releases, as appropriate.
Ohio Water Well Standards	OAC 3745-9-10 Upon completion of testing, a test hole or well shall be either completely filled with grout or such material as will prevent contaminants from entering groundwater.	Applicable	Test borings and/or wells might be installed or utilized as part of the project activities. Abandonment of any borings or wells during the duration of this project will comply with established site procedures that address this requirement.
Corrective Action for SWMUs (Solid Waste Management Units)	40 CFR Subpart S 40 CFR 264.552 and 553 Corrective Action Management Units (CAMUs) might be designated at the site as areas where remediation wastes (solid, hazardous, or contaminated media and debris) might be placed during the process of remediation. Temporary units (TUs) consisting of tanks and container storage units might be used to store and treat hazardous waste during the process of corrective action.	Relevant & Appropriate	During this treatability study, materials could be managed in containment buildings, TUs, stockpiles or other land-based units for the purpose of staging, treating, or disposing the material without triggering the land disposal restrictions (LDRs).

000153

Chemical, Location, or Action	Requirement	ARAR/TBC	Strategy for Compliance
Radiation Dose Limit (All Pathways)	DOE Order 5400.5, Chapter II, Section 1.a The exposure of members of the public to radiation sources as a consequence of all routine DOE activities shall not cause, in a year, an effective dose equivalent greater than 100 mrem from all exposure pathways.	To Be Considered	Operation of the OU4 Pilot Plant could result in release of radiation sources that could contribute to the total dose to members of the public. The facility design will include HEPA filtration to control radionuclide and particulate emissions where appropriate. Excavations, excavated soil and other sources of particulate emissions will be controlled, as appropriate, through good construction practices. Monitoring of air emissions will be conducted in accordance with the methods referenced in 40 CFR 61.93 with compliance being demonstrated using an EPA approved computer code. Releases to water will be controlled by design and operation of secondary containment features and treatment in the FEMP WWTS.
Control of Visible Particulate Emissions	OAC 3745-17-07 Particulate emissions from a stack shall not exceed specified opacity limits.	Applicable	The facility design will include HEPA filtration to limit and control particulate emissions.
Control of Fugitive Dust	OAC 3745-17-08 Requires the minimization or elimination of visible emissions of fugitive dust generated during grading, loading, or construction operations and other practices which emit fugitive dust.	Relevant and Appropriate	Excavations, excavated soil and other sources of fugitive dust emissions during construction will be controlled, as appropriate, through established FEMP construction practices.

000154

Chemical, Location, or Action	Requirement	ARAR/TBC	Strategy for Compliance
Restriction on Particulate Emissions from Industrial Processes	OAC 3745-17-11 Any source (operation, process, or activity) shall be operated so that particulate emissions do not exceed allowable emission rates specified in this regulation (based on processing weights (Table 1) or uncontrolled mass rate of emissions (Figure II)). A source complies with Table 1 requirements if its rate of particulate emission is always equal to or less than the allowable rate of particulate emission based on the maximum capacity of the source: Process Rate at Maximum Capacity (lb/hr) — Allowable Rate of Particulate Emission (lb/hr)[1] 100 — 0.551 200 — 0.877 400 — 1.40 600 — 1.83 800 — 2.22 1000 — 2.58 [1] Excerpted from Table 1 of OAC 3745-17-1	Applicable	The facility design will include HEPA filtration to minimize particulate emissions to less than these maximum emission rates.
Prevention of Air Pollution Nuisance	ORC 3704.01-.05 OAC 3745-15-07 Measures shall be taken to adopt and maintain a program for the prevention, control, and abatement of air pollution in order to protect and enhance the quality of the state's air resource so as to promote the public health, welfare, and economic vitality of the people of the state. The emission or escape into open air from any source whatsoever of smoke, ashes, dust, dirt, grime, acids, fumes, gases, vapors, odors, and combinations of the above in such a manner or in such amounts as to endanger the health, safety, or welfare of the public or to cause unreasonable injury or damage to property shall be declared a public nuisance and is prohibited.	Applicable	Where appropriate, the facility design will include HEPA filters to control particulate emissions and an off-gas scrubber for treatment of acidic gas emissions. Excavations, excavated soil and other sources of particulate emissions will be controlled, as appropriate, through established FEMP construction practices.

000155

Chemical, Location, or Action	Requirement	ARAR/TBC	Strategy for Compliance
Permit to Install	OAC 3745-31-05(A)(3) The installation of new sources or modification of existing sources requires the use of best available technology to control emissions.	Relevant and Appropriate	Though a permit to install is not required for the Pilot Plant (permits are administrative requirements which are excluded under CERCLA), the substantive requirements must be met by employing BAT for treating particulate and off-gas emissions from the Pilot Plant vitrification unit. This requirement will be met by using an off-gas scrubber for treatment of acidic gas emissions followed by HEPA filters for particulate removal.
Nationwide Permit Program	33 CFR 330 The discharge of dredged or fill material into wetlands or waters of the U.S. must be conducted in compliance with the terms and conditions of the U.S. Army Corps of Engineers' (ACOE) Nationwide Permits (NWPs) as promulgated in 33 CFR 330 Appendix A.	Applicable	Construction of Pilot Plant access roads and utility lines will result in minor wetland disturbances. All dredge and fill activities related to construction of these access roads and utility lines will be conducted in accordance with the substantive terms and conditions of Nationwide Permit 12 - Utility Line Backfill and Bedding. The OEPA has been granted Section 401 State Water Quality Certification for NWP 12.
NEPA Compliance	10 CFR 1021.2 DOE actions must be subjected to NEPA evaluation as outlined by Council on Environmental Quality regulations in 40 CFR 1500-1508.	Applicable	This requirement is applicable because FEMP is a DOE facility, and this requirement requires NEPA evaluation for specific actions at DOE facilities. NEPA documentation will be prepared for this project in accordance with established site procedures.